Appendix E

June 28, 2010, Letter,
Brian L. Buniva, Eckert Seamans

July 27, 2010, Engineer's Review and Analysis Report,
Balzer and Associates

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July 28, 2010

Julia H.C. Wellman
Environmental Impact Review Coordinator
Virginia Department of Environmental Quality
Division of Environmental Enhancement
Office of Environmental Impact Review
629 E. Main Street, Sixth Floor
Richmond, Virginia

Re: Environmental Impact Review for the Proposed Virginia State Law Enforcement Training Facility (VSLETF) – Old River Trail, Powhatan County, Virginia

Dear Ms. Wellman:

I write on behalf of my clients, William Arrington who resides at 3590 Old River Trail and Edward Tillman who resides at 3990 Old River Trail in Powhatan County. In addition to these clients, I have consulted with other Powhatan County citizens living along Old River Trail and its environs as well as residents in Goochland County whose homes are down range from the proposed firing range. Suffice it to say that all of these people have grave concerns over the proposed VSLETF firing range and its likely impact on the peaceful and quiet enjoyment of their homes and farms.

Introduction

I understand that pursuant to Va. Code § 10.1-1188, you have been designated as the Environmental Impact Review Coordinator for the evaluation of the Environmental Impact Report prepared by Mactec Engineering and Consulting, Inc. of Lexington, Kentucky (the "Impact Report") for this ill-conceived project on behalf the Virginia State Police, which is the "Proponent Agency" for this "Major State Project" as those terms are defined in Va. Code § 10.1-1188 and the November 2008 guidance document entitled "Procedure for Environmental Impact Review of Major State Facilities" (the "Guidance Document") prepared by the Virginia Department of Environmental Quality ("VDEQ").

As you know the Code requires the VDEQ to "review and make a statement to the Governor commenting on the environmental impact of each major state facility." The VDEQ statement is to be available to the General Assembly and to the general public at the time of the submission of the VDEQ statement to the Governor. Va. Code § 10.1-1189. The State Comptroller shall not authorize payments of funds from the state treasury for a "Major State Project" "unless the request is accompanied by the written approval of the Governor after his consideration of the comments of the Department [the VDEQ] on the environmental impact of

the facility. Va. Code § 10.1-1190. This statutory mandate was re-emphasized by this year's budget bill, Acts 2010, c. 874, § 4-4.01 i.2, effective for the current biennium ending June 30, 2010, which provides, "The requirements of § 10.1-1190 of the Code of Virginia, shall be met prior to the release of funds for a major state project, provided, however, that the Governor is authorized to release from any appropriation for a major state project made pursuant to this act such sum or sums as may be necessary for the preparation of the environmental impact report required by § 10.1-1188, Code of Virginia." Clearly the law of this Commonwealth demands a careful and searching consideration of the environmental impact of this proposed firing range. It is our considered judgment that the mandated consideration of environmental impacts undertaken by the VSLETF Impact Report is woefully lacking and does not meet the letter or the spirit of the law. Accordingly, we respectfully request that the VDEQ's statement to the Governor note that the proposed firing range has significant adverse environmental and safety impacts on the public and that the facility should be proposed for any one of several alternative locations.

Funding

According to the Impact Report the proposed firing range will be located on a 35 acre parcel of farm field adjacent to Old River Trail on the south and the Deep Meadows Correctional Center Canine Training Facility in Powhatan County immediately to the east.

A review of the documents in the VDEQ file on this project indicates that the Department of Corrections transferred land to the Virginia State Police in March 2010 pursuant to amendments to the 2008-2010 Biennial Budget enacted during the 2009 session of the General Assembly. Curiously, the Biennial Budget (2009 Session, Chapter 781, item 147.10 authorizes $1,875,000 for the construction of a "Target Practice Range" with funding sources identified as "Special" ($400,000), "Trust and Agency" ($185,000), and "Federal Trust" ($1,290,000). In addition, the Budget contains a directive stating, "The Department of Corrections shall transfer *18 acres of land* located adjacent to the Powhatan Correctional Center to the Department of State Police for construction of this project." (Emphasis supplied). Accordingly, contrary to the Impact Report, the law of the Commonwealth has only authorized 18 acres, not 35 acres, to be transferred to the State Police for this project.

Further, it is less than clear as to the source of the funding for this project. As noted above, the Biennial Budget indicates funding sources, which is elaborated on in the summary of "Capital Outlay" accompanying the Biennial Budget on page 119 under "Department of State Police" as follows:

> -- *Target Practice Range.* Provides $1.9 million from nongeneral funds for construction of a target practice range that will be used as a joint training facility by the Department of State Police, the Federal Bureau of Investigation, --

> Richmond Field Division (FBI) and the Virginia Department of Game and Inland Fisheries (DGIF). *The FBI is contributing $1.3 million, DGIF is contributing $0.4 million from their Special Funds, and State Police will contribute $0.3 million from Federal Asset Forfeiture Funds.*" (Emphasis supplied).

In a written response to an inquiry from the Honorable J. Randy Forbes dated July 15, 2010, the FBI's Assistant Director of the Training Division, Janet L. Kamerman, appeared to contradict the project funding information presented to the General Assembly and the Governor during the 2009 session as presented in the Biennial Budget. Specifically the FBI stated, "No contract has been signed by the FBI, *nor has funding been identified.* A Memorandum of Understanding exists between the state agencies involved and the FBI." A copy of the letter to Congressman Forbes is attached as Exhibit # 1. Accordingly, although the Biennial Budget indicates that 68% of the funding for the proposed firing range is to come from the FBI, it now appears that such funding source is in jeopardy and will have to be provided by a new appropriation from the General Fund.

Description of the Proposed Firing Range "Facts"

The following basic characteristics of the proposed firing range, including the proposed design, weaponry, and use of the facility is provided by the Impact Report, the construction plans prepared by the consultant, (Mastec Engineering and Consulting, Inc. of Lexington, KY), correspondence and emails obtained through Freedom of Information Act requests authored by the Virginia State Police, public comments made by representatives of the Virginia State Police at a June 8, 2010 public meeting conducted at the request of and with the assistance of Delegate Lee Ware, Senator John Watkins in Powhatan County. The key characteristics of the project follow.

1. The project will be constructed in four (4) phases. Funding (subject to the uncertainty described above) is for Phase I only. Phase 1 will consist of construction of one (1) 300 yard rifle range and three (3) 50 yard pistol ranges, with a total of 81 shooting lanes for all four ranges. The 300 yard rifle range will have approximately 15 shooting positions, with the remaining shooting positions divided among the three 50 yard pistol ranges. Phase 1 will also include range towers for each range, bleachers, perimeter earthen berms behind the target area and on the perimeter sides of the ranges, a stormwater management system including drain inlets, outlet pipes, culverts, and a bio-retention pond, a groundwater well, toilet facilities and a septic system and drainfield, and a gravel parking lot sufficient to accommodate two hundred (200) parking spaces.

2. Phase 2 will include construction of a 4800 square feet (S.F.) classroom building for up to 200 students and instructors. Phase 3 will include a 2500 S.F. "live shoot house building", and Phase 4 will include construction of a 7200 S.F. dormitory/bunk house building to accommodate sixty (60) overnight guests.

3. The total land disturbance is anticipated to be 14 acres not including construction of an access road from Old River Trail, a Virginia Scenic Byway.

4. Behind the target area a 20' tall earthen berm immediately preceded by a shorter concrete backstop will be constructed just beyond the target locations, which is slightly more than 300 yards down range from the shooter line. In addition two 15' earthen berms will be constructed on the east and west sides of the shooting ranges, creating a U type configuration.

5. All shooting will be in a northerly direction toward the James River, approximately 1.2 miles from the shooting line, and toward Goochland County.

6. The shooter positions on the ranges will be at the top of a rolling hill at an elevation of approximately 290' above mean sea level (msl) and the property slopes downward approximately 2% to 12% as the land approaches the James River. Based upon the site plans for the project, it appears that the shooters line will be 3 to 5 feet higher in elevation than the location of the targets downrange on the 300 yard rifle range. Thus the shooters will be firing their weapons downhill.

7. The type of weapons anticipated to be used are .357 caliber magnum pistols, shotguns, .223 caliber rifles, and .308 caliber sniper rifles. According to a June 21, 2010 letter to Mr. Thomas Ford of Goochland County (who testified that he is directly across James River in Goochland County from the shooting range) from Virginia State Police Superintendent Colonel Flaherty (copy attached as Exhibit # 2), the .223 caliber rifle fires a 62 grain bullet that will travel 9,828 feet fired at a 37° angle and is unobstructed or a distance of 1.86 miles, which is approximately ½ mile north of the James River into Goochland County. The .308 caliber sniper rifle fires a 168 grain bullet that will travel 15,842 feet fired at a 37° angle and is unobstructed or a distance of more than 3 miles, which is nearly two miles north of the James River into Goochland County, well past State Route 6. The velocity of the .223 round is approximately 2700 feet per second. The velocity of the .308 round is approximately 2600 feet per second.

8. The range would be utilized Monday through Friday, primarily during daylight hours, though there will be some "low light training or night time qualifications." Virginia State Police spokesmen at the June 8 public meeting in Powhatan estimated that all three agencies would use the ranges approximately 21 out of the 52 weeks in a year to start, with the possibility of increased usage depending upon future training necessities.

9. Superintendent Flaherty also indicated that the decibel (db) level of the .223 caliber rifle is 120.6 decibels at 50 yards. No sound studies under similar conditions to those that will be created at the proposed firing range have been performed and no information was provided for the decibel level created by the higher powered .308 caliber rifle or the .357 magnum pistols.

10. No formal noise study has been performed according to the Impact Report under review. In response to comments at the public meeting, Virginia State Police representatives submitted the following information to VDEQ in a June 28, 2010 letter (copy attached as Exhibit # 3). Additional evergreen plantings will be placed on top of the 15' and 20' berms to reduce noise impact. Although no professionally qualified noise study has been performed, the State Police

report they have taken "actual sound level measurements with all weapons we would be using at the range facility." The measurements were taken at the range in Goochland, which has a very different configuration and setting than the proposed firing range.[1] Even though we dispute the applicability of the readings to the proposed site due to multiple and unexplained variables, the State Police readings at Goochland indicate decibel readings ranging from 118.6 to 122.3 at the point of the shooter depending upon the weapon discharged, and decibel readings of a low of 75.3 to 92.4 at a distance of 2400' from the shooter.[2]

11. After receipt of Exhibit # 3, the VDEQ again asked the VSP for "an analysis of alternative project sites." VSP provided that analysis in a six sentence email dated July 1, 2010, which is attached hereto as Exhibit # 4. Brunswick County (which has requested that the facility be located on the Department of Corrections facility slated to be closed) was rejected because "too much time would be lost in travel to and from the facility to make it a practical site." Further the email continued, "The Fort Picket site is closer but not as practical as the Powhatan Site, *also since the FBI is providing the most significant amount of funding for the project they had certain restrictions on how far from their Richmond office they were willing to locate the facility."* (Emphasis supplied). Thus a federal agency who has advised a Member of Congress that no federal funds have been designated for this facility, is controlling the location of the proposed facility that is to be owned and operated by the Virginia State Police.

12. No traffic study has been performed.

13. On April 8, 2010 VDEQ suspended review of the Impact Report. The VDEQ letter (copy attached as Exhibit # 5) noted, "The EIR submitted on February 9, 2010, included deficiencies with regards to potential environmental, historic and agricultural resources and facility siting information. The County [of Powhatan] was unable to complete its review because the EIR did not include adequate information regarding the noise reduction features, potential transportation impacts, lighting plans, utility lines, the lead management plan, security at the facility, effects on historic sites and the potential loss of agricultural facilities." VDEQ requested additional information with respect to these issues and in addition sought "information as to whether the facility will affect Old River Trail, further explanation of the existing challenges stated in the EIR (page 4-5) that prevents the renovation of the existing facilities, the full analysis of Alternative B, the facility's relationship to Shiloh Baptist Church, the potential impact of the facility on agricultural production and whether the land is prime agricultural land, and additional information on the lead recovery plan and how the facility may affect traffic in the area."

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[1] Upon information and belief, rather than shooting down hill as the shooters at the proposed facility will do, the Goochland range at James River Correctional Center has shooters facing a natural hill backdrop considerably taller than the 20' berm proposed at the proposed site and natural features muffle the sound much more than can be accomplished under the proposed design.

[2] The direction from the shooter where the readings were taken allegedly 2400' distant is unknown. Of course the State Police have provided zero information regarding the impact of the sound upon human beings, wildlife and farm animals when it continues over the several hours per day that the proposed firing range will be in use.

A review of the VDEQ files conducted on July 22, 2010 disclosed that the only responses supplied by the Virginia State Police to the April 8, 2010 suspension letter are contained in Exhibits 2, 3, and 4 attached to this letter. It is obvious that these responses are inadequate and frustrate the statutorily mandated environmental impact review contemplated by Va. Code § 10.1-1188, *et seq.* Accordingly, we respectfully suggest that for this reason alone, the VDEQ report to the Secretary of Administration and ultimately to the Governor note that an inadequate Environmental Impact Report has been performed by VDEQ and thus the project should not be allowed to proceed.

Although the "proponent agency" has done a woefully inadequate job of presenting a fair evaluation of the proposed project, my clients have found it necessary to spend their own money hiring experts from Balzer and Associates to evaluate the flawed design and negative acoustical impact of the proposed firing range. Upon review of their attached reports, one can only conclude that the proposed facility cannot in good conscience or with the exercise of common sense be allowed to proceed on public safety, historic, and environmental grounds.

Safety Issues

While we do not purport to provide a comprehensive engineering analysis of the design flaws for the proposed firing range, we have reviewed the basic design proposed in the Impact Report and compared that to standards provided by reputable and generally accepted organizations and agencies. A comparison demonstrates that the proposed design for the proposed firing range is woefully inadequate, and quite frankly dangerous to life and limb for a distance of approximately 3 full miles from the shooters' lines.

Range Design

One source on safe range design that we have examined is a document entitled, "Range Design Criteria" developed by the Office of Health, Safety and Security of the U.S. Department of Energy, November 2008, and is available online at *http://www.hss.energy.gov.*[3] The document proposes a series of common sense design features, which remarkably are missing from the design proposed in the Impact Report. Some of the design characteristics cited in the report are:

- Live–fire ranges should be designed to prevent injury to personnel and to property damage outside the range from misdirected or accidental firing and ricochets.
- An open range may be established *provided that enough distance and land area* [is] available to allow for surface danger zones (SDZs) appropriate for the weapons to be used. Lack of SDZs may require baffled ranges, either wholly enclosed or enclosed on all four sides.

[3] This document is included as an appendix to the engineering sound and safety report prepared by Balzer and Associates, which is attached hereto, hereafter (the "Balzer Report").

- Outdoor range sites should be remote from other activities but accessible by road. SDZs should not extend across traveled roads, navigable waterways, railroads, or other areas.
- The best site is one with a natural backstop for projectiles to reduce the cost of constructing earth impact berms and to provide natural sound abatement.
- Firing into upward sloping land and land with natural backstops of hills or mountains is recommended.
- SDZs should be established to contain all projectiles and debris caused by firing ammunition and explosives. A basic SDZ consists of three (3) parts – impact area, ricochet area, and secondary danger area.
- The primary danger area established for the impact of all rounds extends 5° to either side of the left and right limits of fire ***and downrange to the maximum range of any ammunition to be used on the range.*** (Emphasis supplied).
- The ricochet area is 5° to either side of the impact area ***and extends downrange to the maximum range of any ammunition to be used on the range.*** (Emphasis supplied).
- The secondary danger area is that area paralleling, and 100 yards outside of, the outermost limits of the ricochet area ***and extending downrange to the maximum range of any ammunition to be used on the range.*** (Emphasis supplied).
- Boundaries of SDZs must be posted with permanent signs warning persons of the danger of the live-fire range and prohibiting trespassing.
- Limit of fire markers, both external and internal, must be placed to denote right and left limits of fire.
- Permission to deviate from established SDZ requirements must be supported by a safety risk analysis.
- Natural terrain such as a mountain or a hill provides an excellent backdrop for firing. ***The terrain should be high enough to capture rounds fired at up to a maximum 15° muzzle elevation***.
- With respect to "impact structures" or berms, "For open ranges, the top elevation of the each impact berm should be 26 feet above the range surface for ranges 100 yards long or longer and 16 feet above the range surface for ranges 50 yards long or less."

The Proposed Location and Design Is Dangerous to Humans

A cursory comparison of these design criteria with the design of the proposed firing range makes it abundantly clear that the proposed firing range is ill conceived and designed and will create an unsafe, dangerous nuisance at its proposed location.

The proposed range is not designed adequately to prevent injury to personnel and to property damage outside the range from misdirected or accidental firing and ricochets. The surface danger zone ("SDZ") for the weapons to be discharged at the proposed range is depicted on sheets C-1, C-1A, and C-2 incorporated into the Balzer Report. The SDZ for a 45 caliber

pistol is just over 1 mile (5,544 feet) from the firing line. The SDZ for the M-4 carbine (.223 caliber) is 11,276 feet from the firing line, a distance of 2.1 miles, which comes to rest across the James River and just short of River Road, Route 6, a heavily travelled road in Goochland County. The SDZ for the .308 caliber sniper rifle is 17,349 feet, a distance of 3.3 miles from the firing line and approximately a mile north of Route 6 into Goochland County neighborhoods.

Clearly, the proposed range fails to meet the minimum siting and design criteria for open air firing ranges. The SDZ crosses navigable waters (the James River), heavily travelled roadways (Route 6), active railroad tracks (CSX freight trains), and shoots into residential neighborhoods in Goochland County to say nothing of the State Prison farmlands on the Powhatan side of the James River. Indeed, there are approximately 718 developed properties with residences on them within a 3-mile radius of the proposed shooting range, most of which are on the Powhatan side of the James River; however, it appears that approximately 75 residences are within the SDZ zone on the Goochland side of the river and many of them are directly in the line of fire of the proposed range, and thus are at serious risk of bodily harm and property damage. See Exhibit # 6 attached hereto showing parcels and residences within a three-mile radius of the proposed firing range.

Further, rather than shooting into a natural barrier such as a hill serving as a backstop as recommended, the proposed range has the firing range at the summit of a rolling hill with the shooters firing downhill toward the James River and into Goochland County. This terrain, even with construction of the proposed twenty (20) foot berm is clearly not "***high enough to capture rounds fired at up to a maximum 15° muzzle elevation***", which is a basic design criteria. The site for this proposed firing range is not a safe location recommended by the government for establishment of outdoor firing ranges. Indeed, as Sheet C-2 attached to the Balzer Report demonstrates, the rifle muzzle on the firing range will be approximately at elevation 290 msl. Due to the downhill grade of the rifle firing range (Range A), the target will be approximately at elevation 285 msl, 300 yards downrange. Under those conditions the top of the 20' tall earthen berm will only be at elevation 305 msl.

According to calculations performed by Mr. Stokes a retired army officer who served at as a range officer during his career, if a shooter misjudged the target by an increase of approximately 1° of elevation from the firing line the bullet would clear the berm behind the target 300 yards downrange, and hurtle toward a car on Route 6 or one of the residences in the line of fire situated in the SDZ. See Exhibit # 7 attached hereto. We must remember that this is a practice range and that errant rounds are a reality on firing ranges. Accordingly no comfort can be taken in the VSP's cavalier comments that they do not anticipate their shooters will exceed the berm. Indeed, the Balzer Report demonstrates that a mere 0.3° error in elevation will cause a rifle projectile to pass over the berm and into Goochland County. The bottom line is that the range is ill conceived, ill designed, and will put citizens of this Commonwealth at risk by its utilization at this location.

Adverse Noise Impacts

In addition to the safety dangers posed by the proposed range, the Balzer Report also documents that the Environmental Impact Report and subsequent comments of the Virginia State Police do not adequately address or attenuate the likely noise impacts posed by the range. For reasons unknown, the Virginia State Police has not conducted a legitimate acoustical/noise impact study taking into consideration the actual conditions to be experienced at the specific location for the proposed range. Accordingly, my clients were forced to engage their own experts and chose Balzer & Associates to evaluate the information presented and provide as thorough an analysis as possible within the time available based upon the information provided in the Impact Report as supplemented by the Virginia State Police.

According to the Balzer Report, a survey of the representative weaponry utilized by law enforcement agencies causes a peak impulse or sound pressure level ranging from 155 decibels (db) to 168 db. Occupational health limits established by the National Institute of Occupational Safety and Health ("NIOSH") for outdoor noise is 140 db SPL at the point of weapon discharge. The Federal Department of HUD (Housing and Urban Development) noise impact maximum level for outdoor activity areas is only 65 db. Sheet C-3 in the Balzer Report demonstrates that home sites (HS) 9, 10, 11, and 12 are located in the "near field" area of the study adjacent to the firing range. These residences will be impacted with frequent and near continuous discharges that are well above the 65 db HUD noise limits and will be adversely impacted significantly by the firing range. The expected db levels for these four homes under the current design range from 85 db to almost 91 db which will occur continuously for several hours each day (or night) that the range is in operation. If the range was encompassed by a berm at elevation 295 feet msl on all sides the db levels would range from approximately 64 db to nearly 76 db, still above the HUD level. If the range was encompassed by berm at elevation 305 feet msl, the anticipated db level would range from just above 62 db to approximately 72 db.

In Exhibit # 3 the State Police indicated that it conducted sound tests one at the Goochland firing range, which I understand has natural noise attenuation features such as firing into a hill backstop. Contrary to the NIOSH study cited by Balzer, the State Police's one time readings for weapons discharges were approximately 45 db lower. Given the dearth of information as to the scientific reliability of the equipment and test methodology employed or the other variables that apply to scientific acoustical testing, we suggest that the NIOSH study is the more credible of the two. Even with that discrepancy; however, the State Police test found that residences within 2400 feet of the firing range had db levels ranging from 75.3 db to 92.4 db depending upon the weapon discharged. This db range is far in excess of the HUD standard for acceptable outdoor noise levels. Moreover, Home Sites 9, 10, 11, and 13 are less than 2400 feet distant from the firing range. Accordingly, even if the VSP test results are accepted, their own evidence demonstrates that unacceptably high decibel levels will be foisted upon nearby

residents of the firing range and thus they will suffer adverse health and environmental consequences as a result of the construction and operation of this firing range.

Finally, we also bring to your attention the fact that Powhatan County has a "noise ordinance" (copy attached as Exhibit # 8), which makes it unlawful for any person to create, cause or allow on its property sound produced by any machine or device, in such a manner or with such volume or duration that it is plainly audible at a distance of one hundred fifty (150) feet or more from the sound source.

The design of the proposed range does not incorporate sufficient noise attenuation berms surrounding the entire proposed range. Accordingly, the construction and operation of this range will subject these nearby residents to constant noise levels far in excess of the db levels determined to be safe by the federal government.

Adverse Impacts on Historic Properties

As you have already been advised by members of my clients grassroots citizen group organization, the location of the proposed firing range is accessed through a Virginia Scenic Byway known as Old River Trail. It is also surrounded by a number of historic structures that may be eligible for listing on the Federal and/or State registers of historic places such as Pleasant Oak (1795), Shiloh Baptist Church (1866), Massinacack (Glendale – 1849), Michaux Grant (1700s), Hunters Fare (1796), Beaumont (1811), Courthope (1829), St James Chapel and Parsonage (1880 & 1890), Hughes Creek (1833), and Roseneath (1858). See schematic showing the locations of these properties attached as Exhibit # 9.

I also attach copies of two letters to VDEQ and the FBI dated July 14, 2010 and July 13, 2010, respectively (marked as Exhibit # 10 and Exhibit # 11) from the Virginia Department of Historic Resources ("DHR") regarding the historic significance of these properties and the area in general. DHR reiterated its concerns regarding this project's impact to these historic resources and again urged that a National Register evaluation and a formal assessment of the project's impact on these resources be performed. The Virginia State Police has taken no steps to heed this request, but instead asks VDEQ to simply move the project along without this requested study. See VSP letter attached as Exhibit # 3.

DHR has also raised the applicability of Section 106 of the National Historic Preservation Act both to VDEQ and to the FBI. We concur in DHR's analysis and the request made to the FBI, which agency has been characteristically silent throughout this process even to the point of denying it has any records related to this project, a statement which is patently false. See FOIA Request addressed to the FBI along with the FBI response to a FOIA request attached as Exhibit

12.[4] The Environmental Impact review statute explicitly requires consideration of the views of the State's natural and historic resource agencies, and it would be contrary to law for VDEQ to recommend that this project proceed without requiring the study requested by DHR to be performed.

Adverse Impacts to Natural Heritage Resources

The Natural Heritage Division of the Department of Conservation and Recreation ("DCR") has advised VDEQ that the James River Stream Conservation Unit is downstream of the project site and contains aquatic natural heritage resources of high significance 2 miles upstream of the project and 1 mile downstream. See March 8, 2010 letter from DCR attached as Exhibit # 14. One consideration that was not brought to the attention of DCR, but which should be considered by VDEQ in light of the size of the surface danger zone (SDZ) described above, there is an inevitable likelihood that lead shot escaping the target backstops will fall in the flood plain or the James River itself. The significance of this fact is that the errant lead shot (or projectiles made from other hazardous materials) will become hazardous wastes discharging into the James River from the firing range in violation of the Federal Clean Water Act ("CWA"), the Federal Resource Conservation and Recovery Act ("RCRA"), the Virginia State Water Control Law, and the Virginia Waste Management Act. Such unlawful waste disposal practices may well have an adverse effect on the rare and vulnerable aquatic species of concern to the DCR.

While EPA has opined that lead shot falling on property on which the range is located that is owned by the VSP would not be regulated as hazardous waste subject to federal regulation under RCRA, lead shot from errant rounds falling off the VSP site whether in the flood plain, the James River or neighboring properties not owned or controlled by the Virginia State Police, as will inevitably happen should this project proceed, *does* constitute a violation of the Federal Clean Water Act (see, *Weinberger v. Romero-Barcelo*, 456 U.S. 305 (1982)), the Resource Conservation and Recovery Act (see, *Potomac Riverkeeper, Inc. v. National Capital Skeet and Trap Club, Inc.*, 388 F. Supp. 2d 582 (D. Md. 2005)) as well as the equivalent state laws.

The Alternatives Analysis Cannot Pass Muster Under Va. Code § 10.1-1188

The heart of the state statutes, (and the National Environmental Policy Act ("NEPA") which applies where, as here, there are substantial federal funds financing for the state project), evaluating the environmental impacts of projects is the depth and validity of the analysis of

[4] A FOIA request was sent to the Virginia Department of Game and Inland Fisheries at the same time one was sent to VDEQ, the VSP, and the FBI. See Exhibit # 13 attached. All agencies except the VDGIF have responded to the requests, which appears to place VDGIF in violation of the Virginia Freedom of Information Act, Va. Code § 2.2-3700, *et seq.*, which requires an agency to respond to FOIA requests within five (5) working days, which have passed.

alternatives to the proposed project.[5] Indeed, the Code of Virginia requires that the environmental impact report submitted by the Virginia State Police for this project include a meaningful analysis of:

1. The environmental impact of the major state project, including the impact on wildlife habitat;
2. Any adverse environmental effects which cannot be avoided if the major state project is undertaken;
3. Measures proposed to minimize the impact of the major state project;
4. *Any alternatives to the proposed construction*; and
5. Any irreversible environmental changes which would be involved in the major state project.

Va. Code §10.1-1188 (emphasis supplied).

The Impact Report's alternatives consideration clearly violate the spirit and intent of the NEPA and the alternatives analysis mandated by Va. Code § 10.1-1188. The "Alternatives Analysis" consists of one (1) page: Alternative A – renovation of existing borrowed ranges; Alternative B – reduction of the size of the proposed range; Alternative C – construct the proposed range; and Alternative D – take no action.

The Impact Report rejects Alternative A without any analysis by saying, "However, [after acknowledging reduced costs] due to the existing challenges and the agencies increasing training needs, this alternative is not recommended."

The Impact Report rejects Alternative B without any analysis by saying, "This alternative would not provide the required training facilities to accommodate all the partner agencies and staff for their actual training needs."

Alternative C is recommended with the conclusory statement that the proposed project (without any modifications whatsoever) would "meet the partner agencies identified training needs." Nowhere in the Impact Report are the "training needs" of the partner agencies identified. Indeed, review of both VDEQ and VSP documents have not revealed what those training needs are or why the other alternatives do not meet those needs.

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[5] "As a result of this unreasonably narrow purpose and need statement, the BLM necessarily considered an unreasonably narrow range of alternatives." *National Parks and Conservation Association v. Bureau of Land Management, Department of the Interior*, 606 F. 3d 1058, 1072 (9th Cir. 2010). "An agency may not define the objectives of its action in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action, and the EIS would become a foreordained formality." *Id.*, at 1068.

Moreover, the September 2007 Memorandum of Agreement between the FBI, the DGIF, and the VSP describes a proposed firing range considerably smaller than the one described in the Impact Report. The MOA calls for a five (5) acre (vs. 18 acres or 14 acres or 35 acres – whichever one is right) range site with four (4) 50 yard ranges and a single 200 yard rifle range, whereas the Impact Report describes a considerably larger facility with a 300 yard rifle range and three 50 yard ranges with a total of 81 firing positions. The safety and sound analysis described above and in the attached Balzer Report make it clear that even a smaller firing range is inappropriate at this site; however, the very fact that the governing MoA calls for a smaller range than that described in the Impact Report demonstrates the inadequacy of the alternatives analysis performed on behalf of the Virginia State Police.

In a July 1, 2010 email to you the Virginia State Police Representative expanded on the "Alternatives Analysis" with the following statement.

> As you are aware an offer was made by Brunswick County to relocate the range to that County. Unfortunately the location is not conducive to the personnel who would be using the facility. Almost all of the training will be by personnel who are assigned permanently or temporarily (training academy students). Too much time would be lost in travel to and from the facility to make it a practical site.
>
> The Fort Picket site is closer but not as practical as the Powhatan Site, *also since the FBI is providing the most significant amount of funding for the project they had certain restrictions on how far from their Richmond office they were willing to locate the facility.*

Emphasis supplied. The truth is that the primary reason why alternatives such a Quantico, Fort A.P. Hill (Caroline County), Fort Pickett, or the Department of Corrections facility in Brunswick County were not seriously analyzed is because the FBI, the putative major funding source for this project, has restricted the distance that it is willing to have its agents travel for training. Clearly these are not valid reasons to ignore the safety, noise, historic resource and other impacts described above. We respectfully ask that VDEQ advise the Secretary of Administration, the Secretary for Public Safety, and the Governor that the proposed site is ill-conceived, dangerous to life and limb, adversely affects the environment, and that alternative locations should be considered. As a result, the proposed project should not be permitted to proceed.

Conclusion

As the foregoing clearly demonstrates, the placement of the proposed project is dangerous and will have significant adverse environmental and other impacts on the people of Powhatan and Goochland Counties that are in the vicinity. It will pose a danger to boaters, swimmers, and anglers on the James River as well as the unsuspecting travelers in their vehicles

driving along Route 6. Already VEDQ has been provided with unanimous resolutions adopted by the Board of Supervisors of both Powhatan and Goochland Counties opposing this project. Also VDEQ has received numerous well-reasoned communications from citizens on both sides of the James River opposing this project. The need for this project has not been demonstrated, and it is clear that whatever the undefined and unquantified training needs of the VSP, the FBI, and the DGIF may be, they are simply insufficient to impose the dangers, the noise, and the other adverse impacts on the citizens of this Commonwealth who will be in harm's way if this project is constructed and operated at this location.

On behalf of my clients and the other citizens who will be directly impacted by this proposed project, we hope it will be the pleasure of the VDEQ and the Governor to reject this proposal and have it sited in a safer and more appropriate location.

Respectfully submitted

Brian L. Buniva
Legal Counsel for Citizens of
Powhatan and Goochland
Counties Opposed to the VSP Firing Range

BLB/bb
Enclosures
CC: The Honorable Marla Graff Decker, Virginia Secretary of Public Safety
The Honorable Carson Tucker
The Honorable Senator John Watkins
The Honorable Delegate Lee Ware
The Honorable J. Randy Forbes, Member of Congress
The Honorable Eric Cantor, Member of Congress
The Honorable Jim Webb, U. S. Senator
The Honorable Mark Warner, U.S. Senator
William Arrington and Edward Tillman
Maryclay Smith
John Rick, Esq., County Attorney of Powhatan County
Norman Sales, Esq., County Attorney of Goochland County

EXHIBIT 1

U.S. Department of Justice

Federal Bureau of Investigation

Washington, D. C. 20535-0001

RECEIVED

JUL 12 2010

July 15, 2010

J. Randy Forbes, M.C.
Colonial Heights, VA

Honorable J. Randy Forbes
Member of Congress
2903 Boulevard, Suite B
Colonial Heights, Virginia 23834

Dear Congressman Forbes:

I am writing in response to your letter dated June 9, 2010, regarding support by the Federal Bureau of Investigation of an initiative by the Virginia State Police and the Virginia Department of Game and Inland Fisheries. After a discussion with the aforementioned state agencies regarding a mutual under-addressed training requirement, the agencies agreed to work together in mutual support of their requirements.

The FBI provides support to state and local law enforcement agencies, where there is an overlapping training interest. This reduces overall taxpayer expense, and benefits the involved agencies. Most agencies are financially challenged in our current economic downturn, and cannot afford the significant expense of travel and lodging to remote locations. The expense is compounded by reduced law enforcement coverage while law enforcement officers are traveling for training. In this particular situation, the FBI has offered to assist the Virginia State Police and the Virginia Department of Game and Inland Fisheries in the development of the range proposed by their agencies.

In recognition of the very important role training plays in public safety, the FBI will be working in partnership with the Virginia State Police and Virginia Department of Game and Inland Fisheries, providing partnership support for law enforcement training. Ownership of any proposed site would be with the state of Virginia, based on the state of Virginia entities involved.

No contract has been signed by the FBI, nor has funding been identified. A Memorandum of Understanding exists between the state agencies involved and the FBI.

Honorable J. Randy Forbes

The local field office, Special Agent in Charge (SAC) of the Richmond Division, would be the appropriate local FBI point of contact for this project. Currently, the SAC of this division is Michael Morehart.

I hope this information will be of assistance to you.

Sincerely yours,

Janet L. Kamerman

Janet L. Kamerman
Assistant Director
Training Division

EXHIBIT 2

Colonel W. S. (Steve) Flaherty
Superintendent

(804) 674-2000

COMMONWEALTH of VIRGINIA

Lt. Col. Robert B. Northern
Deputy Superintendent

DEPARTMENT OF STATE POLICE

P. O. BOX 27472, RICHMOND, VA 23261-7472

June 21, 2010

Mr. Thomas L. Ford
1521 Hilltop Circle
Maidens, Virginia 23102

Dear Mr. Ford:

Thank you for your recent request for information with respect to the proposed firearms range facility in Powhatan County. I forwarded your request to our Training Division for a response. According to data collected by the Tactical Operations Unit, the .223 caliber rifle carried by our members fires a 62 grain projectile (bullet) that will travel 9,828 feet if fired precisely at a 37 degree angle and is unobstructed. The .308 caliber sniper rifle utilized by our tactical team's fires a 168 grain projectile (bullet) that will travel 15,842 feet if fired precisely at a 37 degree angle and is unobstructed. These are maximum distances of any ammunition utilized by the Department of State Police.

The velocity of the .223 round is approximately 2700 feet per second; the .308 is traveling approximately 2600 feet per second. While I fully understand your concern regarding errant rounds, the chances of our snipers missing their intended targets and firing a round over the 20 foot berm would be highly unlikely.

The range is to be utilized by the Federal Bureau of Investigation, Department of Game and Inland Fisheries, and the Department of State Police. The range would be utilized Monday through Friday, primarily during daylight hours. Occasional use of the range for low light training or night time qualifications would occur. We do not anticipate the rifle range being utilized 12 hours on any day. In fact, the rifle range will in all probability be utilized less than the other proposed pistol ranges.

The decibel level of the .223 caliber rifle currently carried by State Police personnel is 120.6 decibels at 50 yards. The decibel level when multiple weapons are fired simultaneously is not cumulative. I hope this response has provided you with the requested information.

Should you have further questions or need clarification on any of the information provided, please feel free to contact Captain Lenmuel S. Terry, Commander of our Training Division, at (804) 674-2040.

Thank you for your attention to this matter.

Sincerely,

W S Flaherty

Superintendent

WSF/LST/jcw

EXHIBIT 3

Colonel W. S. (Steve) Flaherty
Superintendent

(804) 674-2000

COMMONWEALTH of VIRGINIA

DEPARTMENT OF STATE POLICE

Lt. Col. Robert B. Northern
Deputy Superintendent

P. O. BOX 27472, RICHMOND, VA 23261-7472

June 28, 2010

Ms. Julia Wellman
Office of Environmental Impact Review
Department of Environmental Quality
P.O. Box 1105
Richmond, VA 23218

Re: Virginia State Law Enforcement Training Facility – Powhatan County
Environmental Impact Review
PC# 156-17805, DEQ # 10-017S

Dear Ms. Wellman:

The Department of State Police (DSP) request that DEQ proceed with the final review of this particular project and proceed with the formal final decision package to the Secretary of Administration.

On June 8, 2010, DSP attended a public information meeting with citizens, county officials and members of the General Assembly. The purpose of the meeting was to share information about the project and exchange comments from all parties in attendance.

There are numerous aspects of the project for which the County is concerned which we cannot address, since it appears that the County does not desire for the project to be located with in the county boundaries and those concerns are not directly related to the operation of the range. We can however, address some of the concerns which are directly related to the use and operation of the range – noise, possible errant ammunition rounds and traffic. In addition, it is our opinion that we have not created any environmental issues with the range.

- Noise Abatement Measures: We have created 15' and 20' minimum earthen berms with additional evergreen plantings on the top to reduce the noise impact. This is the industry standard now used by the FBI and other public safety agencies and has been found to greatly reduce the

- noise impact. In addition we have placed several restrictions on the scheduled use of the range.

- Noise Measurements: We have also taken actual sound level measurements (db) with all the weapons we would be using at the range facility. The measurements were taken at point of the shooter and at 2400 feet away which is according to our measurements the closest residence structure to the planned point of the shooter. The measurements were taken at the range in Goochland. This range is similar to the planned range in Powhatan, however it does not have the level of sound reduction berms that the new range will have.

- Sound Levels: Please keep in mind that the average existing ambient sound level was 65 db at the site when the weapons were fired, i.e. existing background noise.

Type	At Weapon	2400'	Exst. Amb.	Spike
.357 Pistol	120.4	85.6	65	20.6
M-4 Rifle	122.3	90.0	65	25.0
Shotgun	119.9	92.4	65	27.4
MP-5 40 cal.	121.4	75.3	65	10.3
308 Rifle	118.6	90.1	65	25.1

- Errant ammunition rounds: All gun firing will occur towards the James River with a lead collection backstop system in place. In addition the 20 foot high berm to the rear of all range targets will provide additional protection. The rifle range system target backstop is approximately 10,000 feet away from any possible areas of risk and we believe the chance that an errant round will hit any area of risk is very remote.

- Traffic: According to a very careful analysis of the three parties' use of the range, the maximum number of vehicles that would travel to the range is 35 vehicles at a given time. We do not believe this creates any burden to the area or public road system.

- Affects on Church in Vicinity of Range: We have made a commitment to the church leaders of Shiloh Baptist Church that whenever they are conducting any type of formal service at the church we will not conduct

- any range operations. This is of course contingent upon the church giving us an advance notice.

- Historical Significance: Numerous comments have been made about the historical nature of the area. We are unaware and the historical data base available to us by the Commonwealth does not reference any historical property or artifacts that we would directly affect. Again we a proposing a facility that is on and very close proximity to an existing major correctional facility which to our knowledge has not been referenced as affecting any historical properties.

During the small land disturbance that occurred last month, we discovered that the Department of Game and Inland Fisheries was responsible for this occurrence. Evidently they decided to proceed with relocating the road entrance which we had discussed among the agencies approximately one year ago. Once we discovered what was occurring we asked them to stop work and remove all equipment which they did. They had stripped a small area of top soil approximately 20 feet by 150 feet which they repaired the same day. We asked them to do no further work until they received written confirmation from us.

Sincerely,

Ronald L. Rice
Capital Outlay Program Director

EXHIBIT 4

Wellman, Julia (DEQ)

From: Rice, Ronald L. [Ronald.Rice@vsp.virginia.gov]
Sent: Thursday, July 01, 2010 8:55 AM
To: Wellman, Julia (DEQ)
Cc: Irons, Ellie (DEQ)
Subject: RE: DSP response letter

Julia,

I will address your questions in this email, if you need the response in letter form let me know and I will be glad to send you one.

As you are aware an offer was made by Brunswick County to relocate the range to that County. Unfortunately the location is not conducive to the personnel who would be using the facility. Almost all of the training will be by personnel who are assigned permanently or temporarily (training academy students). Too much time would be lost in travel to and from the facility to make it a practical site.

The Fort Picket site is closer but not as practical as the Powhatan Site, also since the FBI is providing the most significant amount of funding for the project they had certain restrictions on how far from their Richmond office they were willing to locate the facility.

Ronnie

Ronnie Rice
Capital Outlay Program Director
Virginia State Police
804-674-2118
Fax 804-674-2447
Ronald.Rice@vsp.virginia.gov

-----Original Message-----
From: Wellman, Julia (DEQ) [mailto:Julia.Wellman@deq.virginia.gov]
Sent: Tuesday, June 29, 2010 4:32 PM
To: Rice, Ronald L.
Cc: Irons, Ellie (DEQ)
Subject: FW: DSP response letter

Ronnie,

Today I received your letter (dated June 28, 2010) regarding the proposed DSP training facility in Powhatan County.

In addition to the information provided in the letter, DEQ OEIR requested an analysis of alternative project sites (please see my email below).

Will you please address the question of alternative project sites and DSP's consideration of these sites?

Regards, Julia

Julia Wellman
Environmental Impact Review Coordinator
Virginia Department of Environmental Quality PO Box 1105 Richmond, VA 23218
Phone: (804) 698-4326
Fax: (804) 698-4319
NEW E-mail: Julia.Wellman@deq.virginia.gov

-----Original Message-----
From: Wellman, Julia (DEQ)
Sent: Tuesday, June 15, 2010 10:41 AM
To: Rice, Ronald L. (VSP)
Cc: Irons, Ellie (DEQ)
Subject: DSP response letter

Hi Ronnie,

Based on our conversation last Thursday (June 10), I understand that DSP will send DEQ OEIR a letter stating DSP intention to move forward with the project as proposed, summarizing DSP's coordination efforts with the county, responding to concerns raised by the County and citizens, and explaining the land disturbance that was on or near the proposed training range project site.

Will you also please include information on alternative project sites and DSP's consideration of these sites? For example, we understand based on a previous conversation with you that DSP had an offer to move the facility to Brunswick County. In addition, citizens have mentioned Fort Pickett as a possible location.

Regards, Julia

Julia Wellman
Environmental Impact Review Coordinator
Virginia Department of Environmental Quality PO Box 1105 Richmond, VA 23218
Phone: (804) 698-4326
Fax: (804) 698-4319
NEW E-mail: Julia.Wellman@deq.virginia.gov

EXHIBIT 5

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
TDD (804) 698-4021
www.deq.virginia.gov

Douglas W. Domenech
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4000
1-800-592-5482

April 8, 2010

Mr. Ronald L. Rice
Capital Outlay Program Manager
Department of State Police
P.O. Box 27472
Richmond, VA 23261-7472

RE: Information Request on the Environmental Impact Report concerning the Virginia State Law Enforcement Training Facility in Powhatan County (Agency Code: 156, Project Code: 17805, DEQ 10-017S)

Dear Mr. Rice:

During the course of the Department of Environmental Quality's (DEQ) coordinated review of the Environmental Impact Report (EIR) for the above-referenced project, Powhatan County indicated that additional information was required from the Department of State Police (DSP) in order to assess the feasibility of this proposed project. The information and subsequent response by DSP are necessary before the Office of Environmental Impact Review (OEIR) can complete the project review and submit the Commonwealth's recommendations to the Governor for approval (delegated to the Secretary of Administration), pursuant to *Virginia Code* sections 10.1-1189 and 10.1-1190 (Environmental Impact Reports of State Agencies) and Executive Order 88(01). Accordingly, we are suspending the current 60-day review of the project pending the resolution of the issue. A new 60-day review period will begin upon our receipt of the necessary revisions. We will, of course, respond as quickly as possible once the necessary information is received.

PROJECT DESCRIPTION

The DSP submitted an EIR for the development of a training facility for law enforcement personnel. The agency is proposing to develop the facility on an 18-acre parcel within the existing Deep Meadows Correction Center in Powhatan County. DSP proposes to construct four firing ranges with associated range towers and two small structures during phase 1, and a classroom building, live fire building and a bunkhouse during

subsequent phases. Approximately 14 acres of land will be disturbed. DSP confirmed the Secretary of Administration approved a land transfer agreement from the Department of Corrections (DOC) for the parcel to DSP on March 11, 2010 (email, R. Rice/J. Wellman, March 17, 2010). DOC states that it has no ownership of the proposed project (email, J. Thurston, J. Wellman, March 17, 2010).

AUTHORITY

The guidance we provide in this letter stems from our responsibilities under the state environmental impact reporting law (*Virginia Code* §§ 10.1-1188 through 10.1-1192) and the *Procedure Manual for Environmental Impact Review of Major State Facilities* (DEQ, 1998, rev. 2003; prepared pursuant to *Virginia Code* section 10.1-1191). Virginia Code § 15.2-2202 A requires that the DEQ distribute a copy of the EIR for every major state project to the chief administrative officer of every locality in which each project is proposed to be located. The purpose of the distribution is to enable the locality to evaluate the proposed project for environmental impact, consistency with the locality's comprehensive plan, local ordinances adopted pursuant to this chapter, and other applicable law and to provide the locality with an opportunity to comment. DEQ is required to distribute the reports to localities, solicit their comments and consider their responses in substantially the same manner as DEQ solicits and receives comments from state agencies.

INFORMATION DEFICIENCIES OF THE EIR

The EIR submitted on February 9, 2010, included deficiencies with regards to potential environmental, historic and agricultural resources and facility siting information. The County was unable to complete its review because the EIR did not include adequate information regarding the noise reduction features, potential transportation impacts, lighting plans, utility lines, the lead management plan, security at the facility, effects on historic sites and the potential loss of agricultural activities.

INFORMATION AND ANALYSIS NEEDS

The purpose of the review is to identify and evaluate the effects of proposed state facilities, and to guide facility siting and design decisions in order to protect important resources, including historic resources. The analysis needed to prepare an EIR helps agencies to assess the effects of development proposals, and to consider alternative actions and mitigating measures to avoid or reduce adverse impacts. Review of the EIR provides the DEQ and other state agencies with information that can be used to recommend project modifications, if needed, and to make recommendations to the Secretary of Administration. Preparation of EIRs assists proponent agencies in developing projects that are consistent with existing land-use policies including local plans and ordinances. Therefore, it is essential that all aspects of a proposal are identified and analyzed in a project EIR.

On March 26, 2010, DEQ received (email, R. Rice/J. Wellman) information from DSP that included the response, which also copied the Powhatan County administrator, from a Powhatan County Board of Supervisor's member Mr. Carson Tucker. In this response, a meeting with the responsible party (in this case DSP) was requested. It is our understanding (email, R. Rice/J. Wellman, April 28, 2010) that DSP has requested a meeting with the Board of Supervisor's member.

In addition, the response requested a site plan that illustrates the perimeter of the proposed earthen berms, the facility's lighting plan and its relationship to the County's dark-sky ordinance (as stated by Mr. Tucker), the location and capacity of utility lines, security, information as to whether the facility will affect Old River Trail, further explanation of the existing challenges stated in the EIR (page 4-5) that prevents the renovation of the existing facilities, the full analysis of Alternative B, the facility's relationship to Shiloh Baptist Church, the potential impact of the facility on agricultural production and whether the land is prime agricultural land, and additional information on the lead recovery plan and how the facility may affect traffic in the area. DEQ also has asked the Virginia Department of Transportation, the Virginia Department of Agriculture and Consumer Services, the DEQ regional office and the Department of Conservation and Recreation to review and respond, as necessary, regarding Mr. Tucker's concerns. DEQ has not received the additional request for information from all the state agencies. In addition, DEQ has contacted the County Administrator, Carolyn Bishop, for confirmation that Mr. Tucker's comments are the official comments for Powhatan County.

Upon receipt of the requested information by DEQ and appropriate analysis, the OEIR will complete its review and provide recommendations to the Secretary of Administration on the impacts of the proposed project. As previously stated, our response time will be 60 days or less in keeping with the legal time frame (see *Virginia Code* section 10.1-1189); we will, of course, make every effort to finish the review as quickly as possible.

If you have any questions, please feel free to call Julia Wellman (804-698-4326) or me (804-698-4325). Thank you for your efforts in this regard.

Sincerely,

Ellie L. Irons, Manager
Office of Environmental Impact Review

Enclosure

cc: Honorable Lisa Hicks-Thomas, Secretary of Administration
Carolyn Bishop, County Administrator
Keith Tignor, VDACS
Roger Kirchen, DHR

Robbie Rhur, DCR
Kelley West, DEQ PRO
Kathleen Regan, MACTEC Engineering and Consulting

EXHIBIT 6

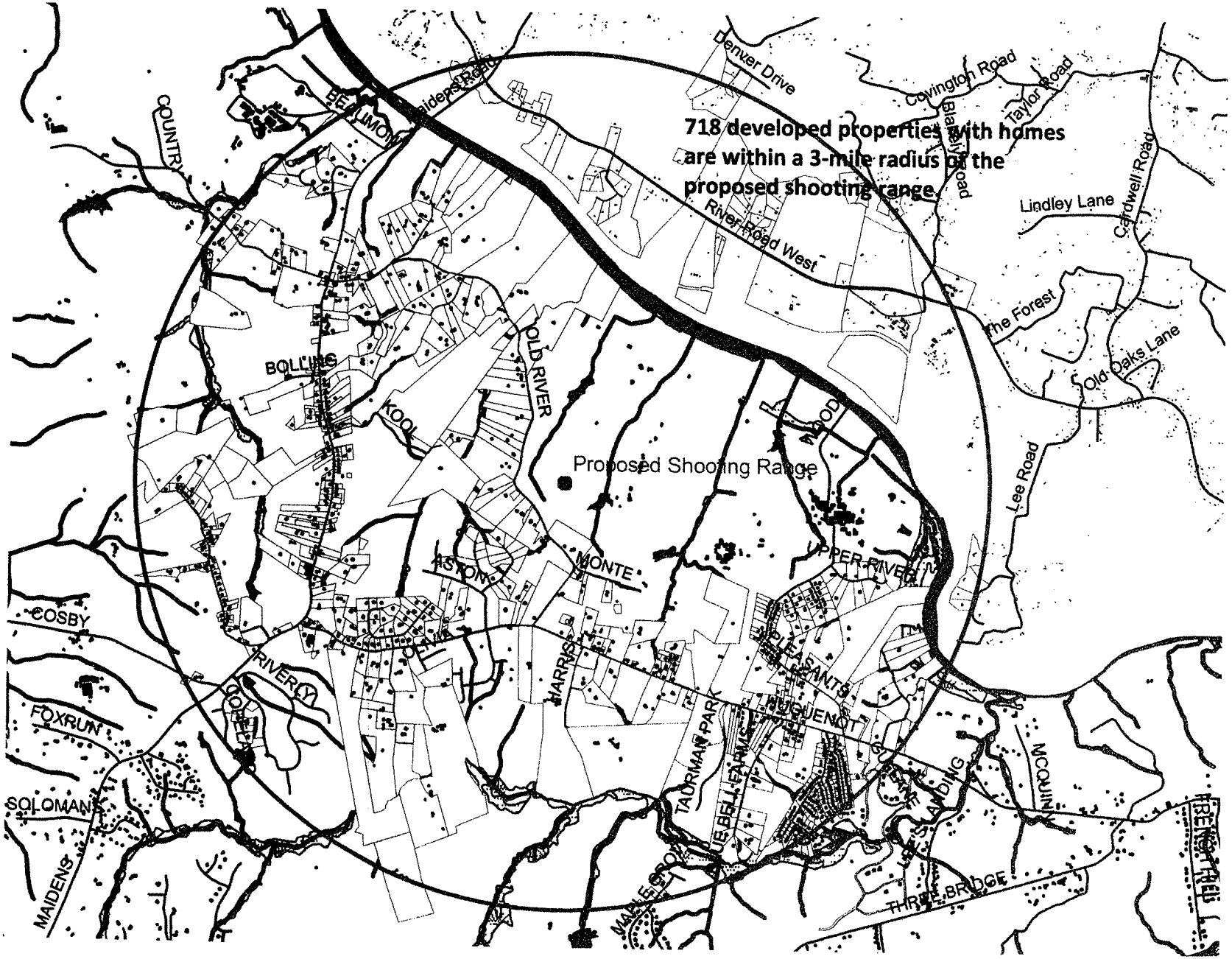

718 developed properties with homes are within a 3-mile radius of the proposed shooting range.
Proposed Shooting Range
Denver Drive
Covington Road
Taylor Road
Blakely Road
Lindley Lane
Cardwell Road
River Road West
The Forest
Old Oaks Lane
Lee Road
COUNTRY
BELLAMONT
BOLLING
KOOL
OLD RIVER
WOOD
ASTON
MONTE
UPPER RIVER
COSBY
RIVERY
FOXRUN
SOLOMAN
MAIDENS
HARRIS
TAURIMAN PARK
HUGUENOT
PLEASANTS
MCQUINN
THREE BRIDGE

EXHIBIT 7

My Concern for Public Safety Regarding the Proposed Firing Range off Old River Trail, Powhatan County, Virginia

Qualification

While serving on active duty as a First Lieutenant, U.S. Army, one of my additional occasional duties was that of Range Officer. My marksmanship skills included the highest rating (Expert) with four weapons: M-1 Garand Rifle, M-1 Carbine, .45 caliber Automatic handgun and .45 caliber Sub Machine gun. Range Officer duties included insuring the safety of all personnel involved in handling and firing weapons while on the firing range and insuring that all rules and procedures are followed.

Observations

Assuming a flat trajectory, if a rifle barrel is elevated only 1.27 degrees above the target at 300 yards the bullet will pass over the top of a 20 foot berm.* My experience as a Range Officer has demonstrated to me that a rifle barrel for many unintentional reasons may point any number of degrees above the target when the trigger is pulled:
Errors include:

-Improper shooter position, while standing, sitting, kneeling or prone
-being startled when the first shot of the exercise is fired
-stung by a yellow-jacket while squeezing the trigger
-improperly handling a misfire

The location of the proposed 300 yard rifle range in an area that does not have an adequate impact zone beyond the 20 foot berm is inherently dangerous to life, limb and property within the maximum range of the ammunition being fired. In my opinion increasing the height and depth of a berm to a height that would prevent rounds going beyond the berm would exceed the practical limitations of berm construction. This can be readily realized by noting that a bullet will pass over the top of a 40 foot berm when the rifle barrel is elevated only 2.54 degrees above the target. Rather than relying on a berm to stop all errant rounds, military ranges have large impact areas in order to safely contain projectiles that travel beyond the berm. Every impact area I have seen on a military installation has been fenced off and identified as "DANGER IMPACT AREA, OFF LIMITS TO ALL PERSONNEL, BY ORDER OF THE POST COMMANDER".

Conclusion and Recommendations

The proposed firing range location presents a severe danger to the public safety. Since there are no bluffs, steep high hills or other natural backstops of suitable height, I have to conclude that it is virtually impossible to construct a safe 300 yard rifle range on the proposed 35 acre parcel. Safe alternative ranges are located at Fort Pickett and Fort A.P. Hill and should be utilized instead of the currently proposed Powhatan site.

*Please see the attached page titled "Angle of Projectile Escape, Trajectory vs. Height of Berm"

Homer S. Stokes, Jr
Powhatan County, Virginia
July 20, 2010

ANGLE OF PROJECTILE ESCAPE

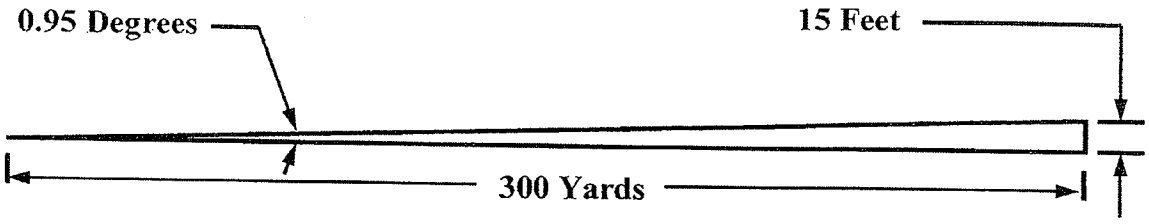
TRAJECTORY VS. HEIGHT OF BERM

Berm Height (ft)	Range Length (ft)	Angle of Escape Trajectory (Degrees)
15	900	0.95
20	900	1.27
25	900	1.59
30	900	1.91
35	900	2.23
40	900	2.54

Note: Angles in table derived by trigonometry: Angle = Inverse Tangent of (Berm Height / Range Length).

TRAJECTORY ANGLE CALCULATION

BY METHOD OF COMPUTER AIDED DESIGN



Note: Angle in Figure above derived by Computer Aided Design (SolidWorks 2010 CAD).

EXHIBIT 8

6-14-10

AN ORDINANCE
TO AMEND THE CODE OF POWHATAN COUNTY
BY AMENDING SECTION 42-32
RELATING TO NOISE

BE IT ORDAINED by the Board of Supervisors of Powhatan County:

(1) That Section 42-32 of the Code of Powhatan County, as amended, is amended to read as follows:

Section 42-1 – 42-30. Reserved.

Section 42-32. Loud noises prohibited.

It shall be unlawful for any person to create, cause to be created or allow on property under the person's control or ownership any of the following:

(a) Sound produced or reproduced by any radio, phonograph, television, record, compact disc or tape player, musical instrument, loudspeaker, sound amplifier, or any other machine or device or human voice in such a manner or with such volume or duration that it is plainly audible between 10:00 p.m. and 7:00 a.m. (i) inside the confines of a dwelling unit, house or apartment of another person or inside a business or place of worship, or (ii) at one hundred fifty (150) or more feet from the sound source.

(b) Noise created by any dog that is so continuous and chronic that it causes annoyance or discomfort to any person, provided that such noise is plainly audible inside the confines of the dwelling unit, house or apartment of another, or plainly audible 300 feet or more from the dog.

No person shall be convicted of a violation of this subsection (b) unless there shall have been before the court competent evidence that the complainant or a law enforcement official or other code enforcement officer had, prior to the issuance of any summons or warrant, requested the abatement of the noise complained of, and that such noise continued at an unlawful level after such request.

(c) Sound played or amplified by any radio, stereo, tape player, compact disc player, loud speaker or other electronic device or mechanical equipment used for the amplification of sound, or produced by any motorbike, motorcycle, ATV, or by any other machine or device, in such a manner or with such volume or duration that it is plainly audible at a distance of one hundred fifty (150) feet or more from the sound source or inside the confines of the dwelling unit, house or apartment of another person, or plainly audible within a business or place of worship.

(d) Plainly audible noise in residential subdivisions between 10:00 p.m. and 5:00 a.m. in connection with the loading or unloading of refuse, waste or recycling collection vehicles.

(e) Plainly audible noise in residential subdivisions between 10:00 p.m. and 7:00 a.m. in connection with lawn care, leaf removal, gardening, tree maintenance or removal and other landscaping, lawn or timbering activities.

(f) This ordinance shall not apply to sounds created by devices permitted to be used at public parks or public recreation fields, or created by public sporting events or school sponsored activities on school property, or duly authorized public parades, public functions or commemorative events. Further, this ordinance shall not apply to sirens, loud speakers or emergency communication radios in public safety vehicles, nor shall it apply to motor vehicle alarms or other security devices.

(g) This ordinance shall not apply to any firearm discharges, except those occurring at non-sport shooting ranges, firing ranges or firearms training facilities **not in operation at the time of adoption of this amendment**. In the event of a conflict between this ordinance and Section 15.2-917 of the Code of Virginia (1950), as amended, the state code provisions shall prevail.

(h) Violations of this section shall constitute a class 3 misdemeanor.

(i) For purposes of this ordinance, tenants shall be deemed to be in control of the property contained within their tenancy.

ADOPTED BY THE POWHATAN COUNTY BOARD OF SUPERVISORS ON _____, 2010.

_____
Robert R. Cosby, Chairman
Powhatan County Board of Supervisors

ATTEST:

_____
Carolyn Bishop, Clerk
Powhatan County Board Of Supervisors

Recorded Vote:
Robert R. Cosby ____
Marsell Bustos ____
C. Scott Daniel ____
Carson L. Tucker ____
Joseph B. Walton ____

EXHIBIT 9

1880 Laprade Map of Powhatan County showing Historic Sites and Historic Nature of "MICHAUX FERRY ROAD" (now Old River Trail). Note Shiloh Church and Pleasant Oak, both Historic Properties. Old River Trail is a designated Virginia Byway. Old River Trail (Michaux Ferry Road) was used by many people to get to the Maidens or Michaux Ferry crossing the James River. This road retains its natural, historic, and scenic beauty. Map of Powhatan County made by Order of the County Court of 1880.

Beaumont 1811

Courthope 1829

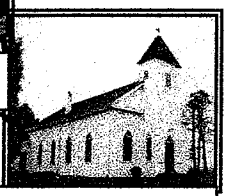
Hunters Fare 1796

Michaux Grant – 1700's

Massinacack (Glendale) 1849

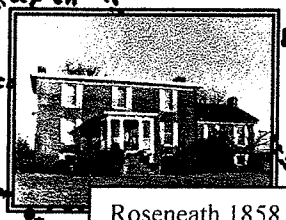
Pleasant Oak 1795

St. James Chapel And Parsonage 1880 and 1890



Shiloh Church 1866

Hughes Creek - 1833



Roseneath 1858

This rendition created by Mary Jane Stokes – Massinacack - May 20, 2010 to represent the Historic District of Old River Trail and Huguenot Trail adiacent to Dept. of Corrections land overlooking the James River. There are other older homes not shown here.

EXHIBIT 10

COMMONWEALTH of VIRGINIA

Douglas W. Domenech
Secretary of Natural Resources

Department of Historic Resources
2801 Kensington Avenue, Richmond, Virginia 23221

Kathleen S. Kilpatrick
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
TDD: (804) 367-2386
www.dhr.virginia.gov

July 14, 2010

Ms. Julia Wellman
DEQ – OEIR
P.O. Box 1105
Richmond, VA 23218

RE: Virginia State Law Enforcement Training Facility
Powhatan County, VA
DHR File No. 2009-1519; DEQ #10-017S

Dear Ms. Wellman:

We have received for consideration additional information in support of the project referenced above. The Department of State Police (DSP) contends in their June 29, 2010 letter that the "historical data base available to us by the Commonwealth does not reference any historic property of artifacts that we would directly affect." While our Archives do not show any recorded historic resource in the proposed footprint of the facility, our records also provide no evidence that the project area has ever been systematically surveyed for historic resources. Furthermore, this project has the potential to indirectly affect the setting, feeling, and character of surrounding resources beyond the limits of the project area.

Since issuing our March 4, 2010 comments, concerns regarding this project's impact to historic resources have been brought to our attention. The historic significance of and potential impacts to Shiloh Baptist Church (DHR ID #072-0087) and Coverdale/Pleasant Oaks (DHR ID #072-0085) have been argued. Our March 30, 2010 correspondence to DEQ highlighted these concerns and included our recommendation for National Register-evaluation of these resources as well as an assessment of potential impact. We reiterate this recommendation and add that the historic significance of and potential effect to other neighboring properties should be considered. Regarding archaeological resources, evidence supporting the potential for undocumented sites within the project area has been provided, including data on adjacent sites and photographs of artifact collected nearby. The potential for archaeological sites within the footprint of the proposed facility should be assessed through a Phase I archaeological survey conducted by a qualified professional and in accordance with DHR's guidelines. As this is state property, a permit from our office is required prior to any archaeological study.

Finally, regarding the applicability of Section 106 of the National Historic Preservation Act, you have been provided a copy of our letter to the FBI concerning this project. It is our position that the funding provided by the FBI is an undertaking subject to Section 106, which requires federal agencies to consider the impact of their projects on historic properties. The federal Advisory Council on Historic Preservation shares this opinion. However, only the FBI can determine whether Section 106 applies in this case as the

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Northern Region
Preservation Office
P.O. Box 519
Stephens City, VA 22655
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responsibility for its compliance lies solely with that agency. We will inform DEQ of any developments concerning this matter.

Regardless of the applicability of Section 106, our recommendation remains for archaeological and architectural survey prior to beginning this project. The results of these studies should be provided to DHR for review and comment. Once we have had the opportunity to review the reports, we will be able to advise the DSP and FBI on the need for additional evaluative or mitigative action.

Thank you for providing the additional information and seeking our comment on this project. We look forward to working with all stakeholders to bring this project to a successful conclusion. If you have any questions regarding these comments and recommendation, please do not hesitate to contact me at roger.kirchen@dhr.virginia.gov.

Sincerely,

Roger W. Kirchen, Archaeologist
Office of Review and Compliance

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EXHIBIT 11

COMMONWEALTH of VIRGINIA

Department of Historic Resources

Douglas W. Domenech.
Secretary of Natural Resources

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Kathleen S. Kilpatrick
Director

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July 13, 2010

Robert Cook
Fire Arms Instructor
FBI Richmond Field Office
1970 East Parham Road
Richmond, VA 23228

Re: Proposed Virginia State Law Enforcement Training Facility
Old River Trail
Powhatan County, Virginia
DHR File No. 2009-1519

Dear Mr. Cook:

The Department of Historic Resources requests clarification of the Federal Bureau of Investigation's role in the proposed development of the Virginia State Law Enforcement Training Facility to be located on Old River Trail on a parcel of land adjacent to the existing Deep Meadows Correctional Center Canine Training Facility.

According to the information sent to us by the Virginia Department of Environmental Quality, the proposed facility is a joint effort among the FBI, the Virginia State Police, the Department of Game and Inland Fisheries and the Department of Corrections. Recently you were kind enough to speak with Ms. Amada Lee of our department. Based on this conversation it is our understanding that the FBI has been part of the planning process for this facility and has provided funding for the environmental review and development of the plan. The FBI may also provide funding for its construction. While the state will manage and maintain the facility, the FBI will participate in a memorandum of understanding to allow the FBI to use the facility in future. However, we further understand that the FBI does not see its provision of federal funding as a federal action but as a state project. Apparently this view is based on the fact that the land on which the facility is proposed to be built is owned by the Commonwealth and that once the funds are transferred, the funds will become state funds. If we have misunderstood the FBI's position, please accept our apologies and do not hesitate to correct us.

It is very important that the Department of Historic Resources, as Virginia's State Historic Preservation Office (SHPO), as well as our sister state agencies, clearly understand the FBI's position on this project. Both our agency and the Department of Environmental Quality have received numerous calls and e-mails expressing concern for the effects of the proposed facility on historic properties. The local government has raised the issue that the Old River Trail is a Scenic Byway. The Powhatan Historical Society and the Michaux-St. James Foundation have expressed concern about Pleasant Oak (DSS# 072-0085), a late 18th Century plantation, and the Shiloh Baptist Church (DSS # 072-0087), established by freed slaves, in particular. Local residents have also raised archaeological and Native American issues. Apparently the area was a large permanent settlement of the Monacan Indian Nation, a state-recognized tribe. During construction in the 1920s on the state-owned lands, burials were uncovered and transferred to the Smithsonian. We have been provided with numerous photographs of artifacts recovered by local collectors.

As you know, a federal law, the National Historic Preservation Act of 1966, as amended, requires federal agencies to consider the effects of their undertakings on historic properties and to offer another federal agency, the Advisory Council on Historic Preservation, the opportunity to comment. An *Undertaking* is defined in the federal regulations implementing Section 106 of the NHPA as a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license or approval. I am attaching a link to the Advisory Council's guidance documents for your convenience. http://www.achp.gov/usersguide.html. Section 106 is a process of consultation. Consultation is required not only with our office as the Virginia SHPO, and the FBI's state agency partners, but with the local government, and others who may have knowledge or concern about historic properties, including the general public. When adverse effects to historic properties are found, consultation must continue on ways to reduce, avoid or mitigate these impacts. It is our opinion that the provision of federal funding for the proposed Virginia State Law Enforcement Training Facility is an undertaking subject to Section 106. We recommend that you initiate consultation pursuant to Section 106.

We are also copying Charlene Vaughan, Assistant Director of the Office of Federal Agency Programs at the Advisory Council on Historic Preservation, on this letter. I am sure that Ms. Vaughan will be very willing to answer any questions you may have about Section 106 and the National Historic Preservation Act.

We look forward to hearing from you. If you have any questions concerning our comments, or if you wish to discuss this further, please do not hesitate to contact me at (804) 367-2323, ext.112; fax (804) 367-2391; e-mail ethel.eaton@dhr.virginia.gov.

Sincerely,

Ethel R Eaton

Ethel R. Eaton, Ph.D., Senior Policy Analyst
Division of Resource Services and Review

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EXHIBIT 12

U.S. Department of Justice

Federal Bureau of Investigation

Washington, D.C. 20535

July 23, 2010

MR. BRIAN L. BUNIVA
ECKERT, SEAMANS, CHERIN & MELLOTT, LLC
SUITE 1450
EIGHTH AND MAIN BUILDING
707 EAST MAIN STREET
RICHMOND, VA 23219

Request No.: 1151235- 000
Subject: PROPOSED VIRGINIA STATE
LAW ENFORCEMENT TRAINING FACILITY

Dear Mr. Buniva:

This responds to your Freedom of Information/Privacy Acts (FOIPA) requests which were sent to FBI Headquarters and the Richmond Field Office.

Based on the information you provided, we conducted a search of the indices to our Central Records System. We were unable to identify responsive main file records. If you have additional information pertaining to the subject and you believe it was of investigative interest to the Bureau, please provide us the details and we will conduct an additional search.

You may file an appeal by writing to the Director, Office of Information Policy (OIP), U.S. Department of Justice, 1425 New York Ave., NW, Suite 11050, Washington, D.C. 20530-0001. Your appeal must be received by OIP within sixty (60) days from the date of this letter in order to be considered timely. The envelope and the letter should be clearly marked "Freedom of Information Appeal." Please cite the FOIPA Request Number assigned to your request so that it may be identified easily.

Enclosed for your information is a copy of the FBI File Fact Sheet.

Sincerely yours,

David M. Hardy
Section Chief,
Record/Information
Dissemination Section
Records Management Division

Enclosure

FBI FILE FACT SHEET

- The primary function of the FBI is law enforcement.
  The FBI does not keep a file on every citizen of the United States.

- **The FBI was not established until 1908 and we have very few records prior to the 1920's.**

- **FBI files generally contain reports** of FBI investigations of a wide range of matters, including counterterrorism, foreign counter-intelligence, organized crime/drugs, violent crime, white-collar crime, applicants, and civil rights.

- **The FBI does not issue clearances or nonclearances for anyone other than its own personnel or persons having access to FBI facilities.** Background investigations for security clearances are conducted by many different Government agencies. Persons who received a clearance while in the military or employed with some other government agency should write directly to that entity.

- **An FBI identification record or "rap sheet" is NOT the same as an FBI "file"** - it is simply a listing of information taken from fingerprint cards submitted to the FBI in connection with arrests, federal employment, naturalization, or military service. The subject of a "rap sheet" may obtain a copy by submitting a written request to FBI, CJIS Division, Attn: SCU, Mod. D-2, 1000 Custer Hollow Road, Clarksburg, West Virginia 26306. Each request must have proof of identity which shall consist of **name, date and place of birth and a set of rolled-ink fingerprint impressions** placed upon fingerprint cards or forms commonly utilized for applicant or law enforcement purposes by law enforcement agencies, plus **payment of $18.00** in the form of a certified check or money order, payable to the Treasury of the United States.

- **The National Name Check Program (NNCP)** conducts a search of the FBI's Universal Index to identify **any** information contained in FBI records that may be associated with an individual and provides the results of that search to the requesting Federal, State or local agency. For the NNCP, a name is searched in a multitude of combinations and phonetic spellings to ensure all records are located. The NNCP also searches for both "main" and "cross reference" files. A main file is an entry that carries the name corresponding to the subject of a file while a cross reference is merely a mention of an individual contained in a file. The results from a search of this magnitude can result in several "hits" and "idents" on an individual. In each instance where UNI has identified a name variation or reference, information must be reviewed to determine whether it is applicable to the individual in question.

- **The Record/Information Dissemination Section/Freedom of Information-Privacy Acts (FOIPA)** search for records provides copies of FBI files relevant to a FOIPA request for information. FOIPA provides responsive documents to requesters seeking "reasonably described information." For a FOIPA search, the subject name, event, activity, business, or event is searched to determine whether there is an investigative file associated with the subject. This is called a "main file search" and differs from The **NNCP** search.

FOR GENERAL INFORMATION ABOUT THE FBI,
CHECK OUT OUR WEBSITE AT
http://www.fbi.gov

3-23-04

ECKERT SEAMANS

Eckert Seamans Cherin & Mellott, LLC
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Brian L. Buniva
804.788.7759
804.698.2950 fax
bbuniva@eckertseamans.com

July 15, 2010

Federal Bureau of Investigation
Attn: FOI/PA Request
Record/Information Dissemination Section
170 Marcel Drive
Winchester, VA 22602-4843

Re: Freedom of Information Act Request
Regarding the Proposed Virginia State Law Enforcement Training Facility (VSLETF) – Old River Trail, Powhatan County, Virginia

Dear Sir or Madam:

I write on behalf of several clients residing in both Powhatan and Goochland Counties in close proximity to the proposed VSLETF.

Pursuant to 5 U.S.C. § 552, *et seq.*, please allow the inspection and copying of all public records, as defined in the Freedom of Information Act ("FOIA"), related to the referenced proposed facility including all electronic mail and paper information and documents. Specifically, and without limitation, we seek copies of any "Memorandum of Understanding" between the FBI, the Virginia State Police ("VSP") and the Virginia Department of Game and Inland Fisheries ("VDGIF") with respect to the referenced proposed training facility, any information regarding funding or other "partnership support" for law enforcement training with the VSP and/or the VDGIF or any other state or local Virginia agencies. This request seeks all writings and recordings that consist of letters, electronic mail and attachments, words or numbers, or their equivalent, set down by handwriting, typewriting, printing, photostatting, photography, magnetic impulse, optical or magneto-optical form, mechanical or electronic recording or other form of data compilation, however stored, and regardless of physical form or characteristics, prepared or owned by, or in the possession of the FBI or its officers, employees or agents with respect to the referenced project. Please advise when it will be convenient for me to review the information responsive to this request.

Very truly yours,

Brian L. Buniva

BLB/bb
cc: Michael Morehart, Special Agent in Charge, Richmond Office of the FBI

EXHIBIT 13

ECKERT SEAMANS

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Eighth and Main Building, Suite 1450
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bbuniva@eckertseamans.com

July 15, 2010

Robert "Bob" W. Duncan, Executive Director
Virginia Department of Game and Inland Fisheries
4010 W Broad Street
Richmond, VA 23230

Re: Freedom of Information Act Request
Regarding the Proposed Virginia State Law Enforcement Training Facility (VSLETF) – Old River Trail, Powhatan County, Virginia

Dear Mr. Duncan:

I write on behalf of several clients residing in both Powhatan and Goochland Counties in close proximity to the proposed VSLETF.

Pursuant to Va. Code § 2.2-3704, *et seq.*, please allow the inspection and copying of all public records, as defined in the Virginia Freedom of Information Act ("FOIA"), related to the referenced proposed facility including all electronic mail and paper information and documents. For your convenience the FOIA defines "Public records" as follows: "all writings and recordings that consist of letters, words or numbers, or their equivalent, set down by handwriting, typewriting, printing, photostatting, photography, magnetic impulse, optical or magneto-optical form, mechanical or electronic recording or other form of data compilation, however stored, and regardless of physical form or characteristics, prepared or owned by, or in the possession of a public body or its officers, employees or agents in the transaction of public business." Va. Code § 2.2-3701. Please advise when it will be convenient for me to review the information responsive to this request.

Very truly yours,

Brian L. Buniva

BLB/bb

EXHIBIT 14

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 326

Richmond, Virginia 23219-2010

(804) 786-2556 FAX (804) 371-7899

MEMORANDUM

DATE: March 8, 2010

TO: Julia Wellman, DEQ

FROM: Roberta Rhur, Environmental Impact Review Coordinator *for* John Davy, Division Director, Planning and Recreational Resources

SUBJECT: DEQ 10-017S, Dept of State Police-VA State Law Enforcement Training Facility, Powhatan

Division of Natural Heritage

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

According to the information currently in our files, the James River Stream Conservation Unit (SCU) is downstream of the project site. SCUs identify stream reaches that contain aquatic natural heritage resources, including 2 miles upstream and 1 mile downstream of documented occurrences, and all tributaries within this reach. SCUs are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant. The James River SCU has been given a biodiversity significance ranking of B3, which represents a site of high significance. The natural heritage resources of concern associated with this SCU are:

Alasmidonta varicosa	Brook floater	G3/S1/NL/LE
Ellipitio lanceolata	Yellow lance	G2G3/S2S3/SOC/SC

Considered good indicators of the health of aquatic ecosystems, freshwater mussels are dependent on good water quality, good physical habitat conditions, and an environment that will support populations of host fish species (Williams et al., 1993). Because mussels are sedentary organisms, they are sensitive to water quality degradation related to increased sedimentation and pollution. They are also sensitive to habitat destruction through dam construction, channelization, and dredging, and the invasion of exotic mollusk species.

In addition, the James Spinymussel (*Pleurobema collina*, G1/S1/LE/LE) has been historically documented in the James River. The James spinymussel is endemic to the James River watershed and occurs in a variety of substrata, ranging from sand and silt mixtures to gravel and sand mixed with rubble, and in a variety of flow regimes (Clarke & Neves, 1984; Hove & Neves, 1994). It is now restricted to small headwater streams of this watershed (Neves, 1991). Threats to the James spinymussel include competition with the exotic clam (*Corbicula fluminea*), erosion and sedimentation from logging, road construction, and livestock grazing, sewage effluent, and water quality degradation (Neves, 1991). Please note that this species is currently classified as endangered by the United States Fish and Wildlife Service (USFWS) and the Virginia Department of Game and Inland Fisheries (VDGIF).

Furthermore, the James River has been designated by the Virginia Department of Game and Inland Fisheries (VDGIF) as a "Threatened and Endangered Species Water". The species associated with this T & E Water are the Atlantic pigtoe (*Fusconaia masoni*, G2/S2/SOC/LT) and the Brook floater.

To minimize adverse impacts to the aquatic ecosystem as a result of the proposed activities, DCR recommends the implementation of and strict adherence to applicable state and local erosion and sediment control/storm water management laws and regulations. Due to the legal status of the Brook floater,the Atlantic pigtoe and the James Spinymussel, DCR also recommends coordination with the U.S. Fish and Wildlife Service (USFWS), the Virginia Department of Game and Inland Fisheries (VDGIF) to ensure compliance with protected species legislation.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (DCR), DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

In addition, our files do not indicate the presence of any State Natural Area Preserves under DCR's jurisdiction in the project vicinity.

New and updated information is continually added to Biotics. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

The Virginia Department of Game and Inland Fisheries maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Shirl Dressler at (804) 367-6913.

Division of Soil and Water Conservation

Erosion & Sediment Control:
The Applicant must prepare a project specific Erosion and Sediment Control (ESC) plan and submit it for review and approval by DCR, if the state agency project results in a land-disturbing activity of equal to or greater than 10,000 square feet. The ESC plan must be approved by DCR prior to any land-disturbing activity at the project site. All regulated land-disturbing activities associated with the project, including on and off site access roads, staging areas, borrow areas, stockpiles, and soil intentionally transported from the project must be covered by the project specific ESC plan. The ESC plan must be prepared in accordance with the Virginia Erosion & Sediment Control Law (VESCL) and Regulations (VESCR) and the most current version of the *Virginia Erosion & Sediment Control Handbook*. The ESC plan is submitted to the DCR Regional Office that serves the area where the project is located. [Reference: VESCL §10.1-560, §10.1-564; VESCR §4VAC50-30-30, VESCR §4VAC50-30-40, §4VAC50-30-100]

Stormwater Management:
The applicant must prepare a project specific Stormwater Management (SWM) plan and submit it for review and approval by DCR, if the state agency project results in a land-disturbing activity of equal to or greater than one acre. The SWM plan must be approved by DCR prior to any land-disturbing activity at the project site. The SWM plan must be approved by DCR prior to any land-disturbing activity at the project site. The SWM plan must be prepared in accordance with the Virginia Stormwater Management Act (VSMA) and the Virginia Stormwater Management Program (VSMP) Permit Regulations. The SWM plan is submitted to the DCR Regional Office that serves the area where the project is located. [Reference: VSMA §10.1-603.5; VSMP Permit Regulations §4VAC50-60-160]

General Permit for Discharges of Stormwater from Construction Activities:
The operator or owner of construction activities involving land disturbing activities equal to or greater than one acre are required to register for coverage under the General Permit for Discharges of Stormwater from Construction Activities and develop a project specific stormwater pollution prevention plan (SWPPP). Construction activities requiring registration also includes the land-disturbance of less than one acre of total land area that is part of a larger common plan of development or sale if the larger common plan of development will ultimately disturb equal to or greater than one acre. The SWPPP must be prepared prior to submission of the registration statement for coverage under the general permit and the SWPPP must address water quality and quantity in accordance with the Virginia Stormwater Management Program (VSMP) Permit Regulations. General information and registration forms for the General Permit are available on DCR's website at
http://www.dcr.virginia.gov/soil_and_water/index.shtml
[Reference: Virginia Stormwater Management Law Act §10.1-603.1 et seq.; VSMP Permit Regulations §4VAC-50 et seq.]

The remaining DCR divisions have no comments regarding the scope of this project. Thank you for the opportunity to comment.

CC: Tylan Dean, USFWS
Ernie Aschenbach, VDGIF

Literature Cited

Conservation status of freshwater mussels of the United States and Canada. Fisheries 18: 6-9.
Clarke, A.H. and R.J. Neves. 1984. Status survey of the James River spinymussel, *Canthyria collina*, in the James River, Virginia. Unpublished report on file with the United Stat es Fish and Wildlife Service, Newton Corner, Massachusetts.

Hove, M.C. and R.J. Neves. 1994. Life history of the endangered James spinymussel *Pleurobema collina* (Conrad, 1837). American Malacological Bulletin 11:29-40.

Neves, R.J. 1991. James spinymussel. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993.

BALZER AND ASSOCIATES INC
REFLECTING TOMORROW

Date: July 27, 2010

Mr. Brian L. Buniva, Esquire
Eckert Seamans Cherin & Mellott, LLC
707 E. Main Street, Suite 1450
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RE: Virginia State Law Enforcement Training Center
Virginia Department of Corrections State Farm
Powhatan County, Virginia
Project Number: 156-09156-003
Balzer and Associates Project No.: C1000375.00

Dear Mr. Buniva,

Balzer & Associates has completed our review of the proposed firing range that is to be located at the Virginia Department of Corrections State Farm site in Powhatan. At the request of our clients, we have reviewed the site plans, prepared by TRS Range Services and MACTEC Engineering and Consulting, Inc. Our review of the plans has been focused toward identifying potential safety and noise issues as they pertain to the proposed firing range.

Based on our initial review, it would appear that the Surface Danger Zone (SDZ) for the site and the environmental impacts due to the noise created by the firing range were not adequately addressed in the plans. While we have not been able to examine any pre-planning documents that may have been created during the planning phase of the project, it is apparent from the construction documents that the SDZ impacts residential areas across the James River, in Goochland County. Additionally, the noise created by the firing range will impact existing residential sites in the vicinity of the proposed site.
Please feel free to let us know if you have any questions or need any additional information.

We have provided the basis for our analysis and associated exhibits to assist in understanding the noise and safety issues that we have identified as being cause for serious concern over the proposed location for the firing range. It is our opinion that these issues are of a

significant enough risk to warrant consideration of alternate sites for the proposed range, or at a minimum, consider revisions to the constructions documents to fully address the noise and life safety concerns.

Sincerely,

BALZER AND ASSOCIATES, INC.

Christopher M. Shust, P.E.
Vice President
Department Head, Site Development

Attachments: Engineer's Review and Analysis Report

Engineer's Review and Analysis Report

For

PROPOSED
VIRGINIA STATE
LAW ENFORCEMENT TRAINING CENTER

VIRGINIA DEPRATMENT OF CORRECTIONS
STATE FARM
POWHATAN, VIRGINIA

Prepared By:

15871 City View Drive
Suite 200
Midlothian, Virginia 23113
Tel.: (804)-794-0571
Fax: (804)-794-2635
Contact: Christopher M. Shust, P.E.
Email: cshust@balzer.cc

July 27, 2010

Table of Contents

Section 1
Executive Summary

This review of the proposed Virginia State Law Enforcement (VSLE) Training Center site considers the possible impact of development for two critical areas: potential life safety impacts created by the firing range; and the disturbance of the peace by the noise created at the firing range. In both areas, our review has identified the potential for significant impacts to the surrounding community by the construction and use of a proposed firing range at the Virginia Department of Corrections State Farm site.

The life safety, or conversely stated, the potential for personal injury or loss of life, is a significant aspect of the citing and design for any proposed firing range. The U.S. Department of Energy, Office of Health, Safety and Security have published a Range Design Criteria Manual (appendix A). Based on guidance set forth in the manual, the proposed VSLE Training Center, if constructed at this site, would bring existing residential property within the limits of the surface danger zone (SDZ) for the types of weapons that are expected to be used at the range. This situation is created by the combination of lateral proximity to the range, perimeter berm construction around the range, and the vertical orientation of the range (a down grade shooting position). Without addressing these concerns, as little as 0.30-degrees of error in shooting scope calibration or human error could create a situation where a bullet would not be contained by the perimeter berming (Figure C1, C1A, and C2 provide plan and profile views of the range).

In terms of the noise that the surrounding residential and agricultural areas will be exposed to, the impact would be considered significant. Based on the sound study performed for the firing range, the existing homes located in the vicinity (Figure C3) of the proposed range would experience noise levels comparable to an airplane taxiing on a runway or a locomotive horn being sounding at a crossing. The summary of HS-NL Data Table (Home Site Noise Level) shows the expected noise levels with the current design. For all 17 home sites considered (including Shiloh Baptist Church and the inmate housing area), the noise levels exceed 74 dB and are as high as 90.6 dB. Again, levels that are consistent with airplane and locomotive noise.

After reviewing the development plan, the Powhatan County Comprehensive Plan, and considering the potential impacts to health, life safety, and general welfare, there are areas of the plan that need to be re-evaluated and possibly modified. These areas include but are not limited to: considering the possibility of choosing a different site; modifying the existing berm configuration to help mitigate safety and noise concerns; and giving consideration to enclosing the range, to mitigate some of the safety and noise issues. In considering the alternatives, there will likely be.

Section 2
Existing Conditions

The area surrounding the proposed VSLE Training Center is characterized by a combination of low-density residential housing and agricultural lands. The proposed site is located approximately 1,000-lf to the north of Old River Trail and is approximately 6,000-lf east of the James River.

Generally speaking the terrain in the vicinity of the firing range could be classified as rolling with steep slope areas along the James River. The State property and surrounding lands have been predominantly used for agricultural type uses, including active crop and pasture land. Due to its proximity to the James River, stormwater drainage generally flows north directly into the River. Given the proximity of the site to the James River, special attention should be given to addressing erosion control and stormwater management/stormwater quality requirements.

The historic Shiloh Baptist Church is located approximately 3,000-lf to the west of the site. The area located to the west of Old River Trail has been identified as Priority Conservation Area and the Shiloh Baptist Church has been identified as a potential Virginia Historic Landmark.

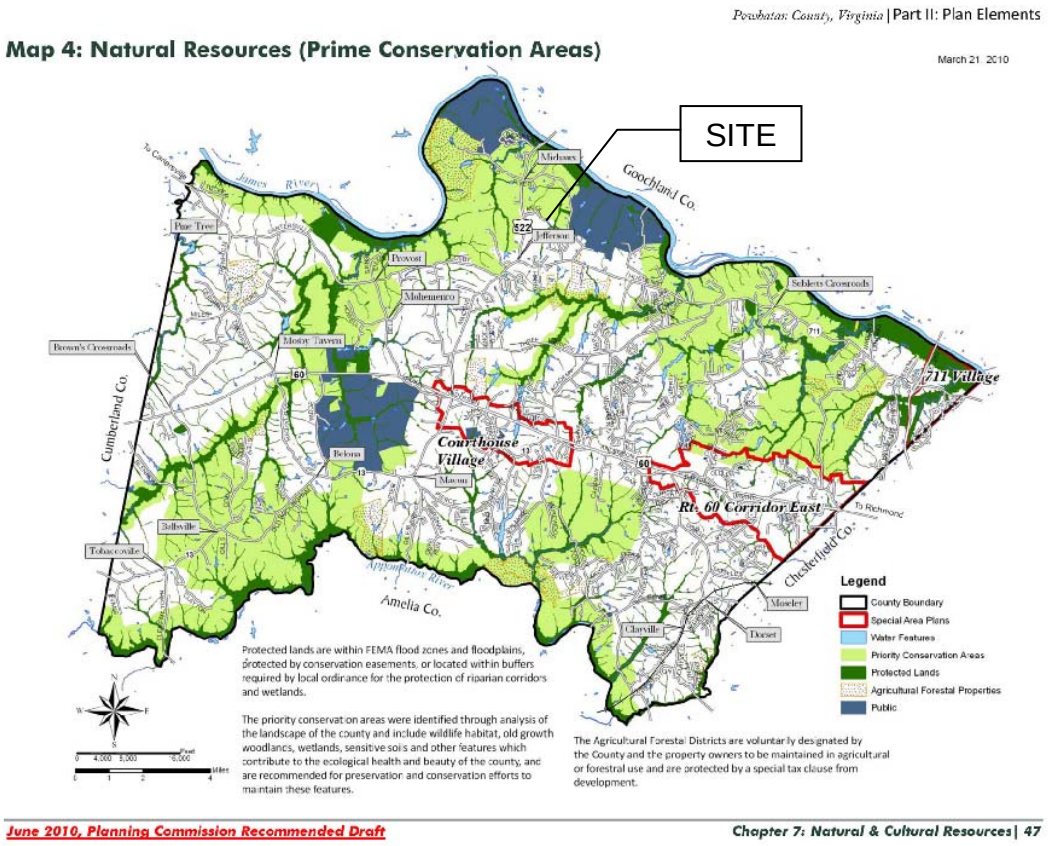


Figure 2-1 Map 4 – Natural Resources Map

Section 3
Zoning and Comprehensive Plan Overview

The current Powhatan County Comprehensive Plan (last revised, 2003) and the current proposed Draft of the 2010 Long Range Comprehensive Plan for Powhatan County are consistent in their identification of existing and future land use for the area in the vicinity of the proposed firing range.

The State owner property is identified in the plan as Public Land Use. In accordance with this classification, the following is an excerpt from the Draft:

" Public land is designated for institutional, governmental uses and publicly owned lands including but not limited to schools, administrative offices, parks, prisons, and other quasi-governmental uses. The pattern or development design of a public area varies from one location to another, but they often have 'campus' like feel with moderate to large scale buildings located on large pieces of land."

The Plan goes on to further describe that the intent of public land should be to provide services and facilities for the operation of government and public operations in an efficient and sustainable manner. The construction of a firing range on the property does not seem to fit with the intended use for Public Land Use, according to the County's Comprehensive Plan.

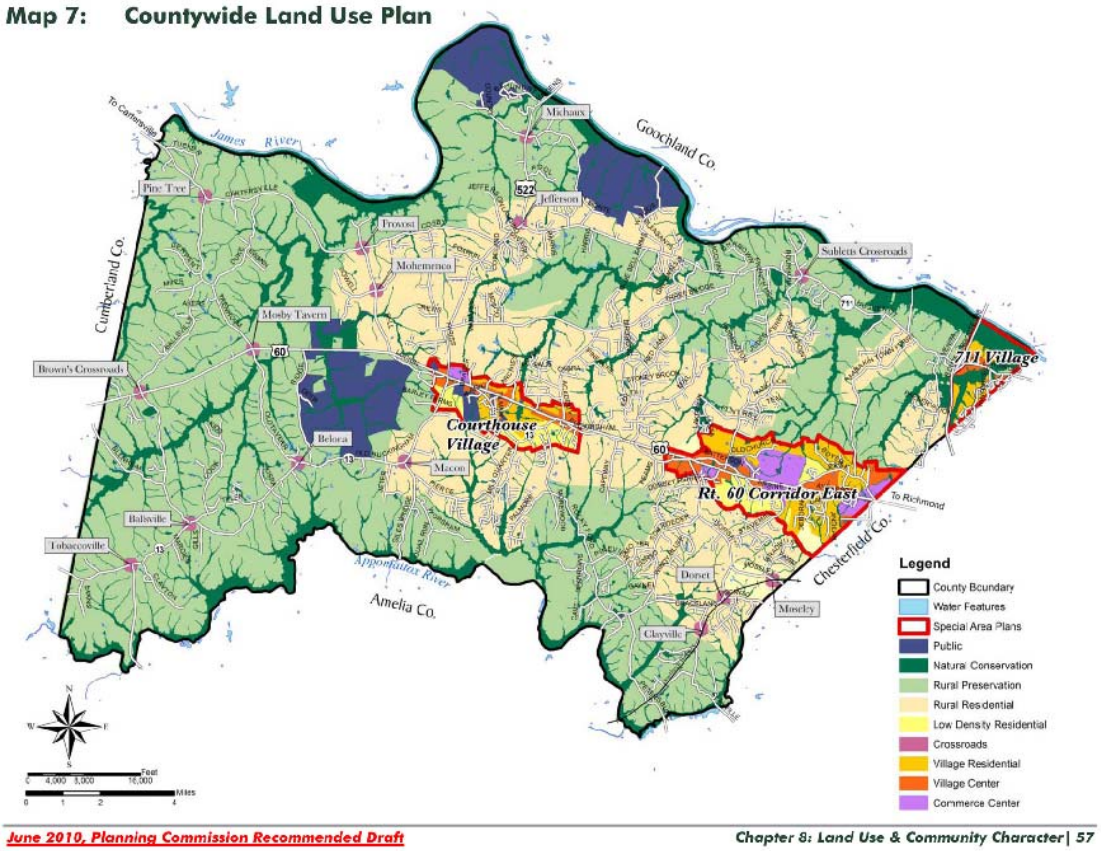


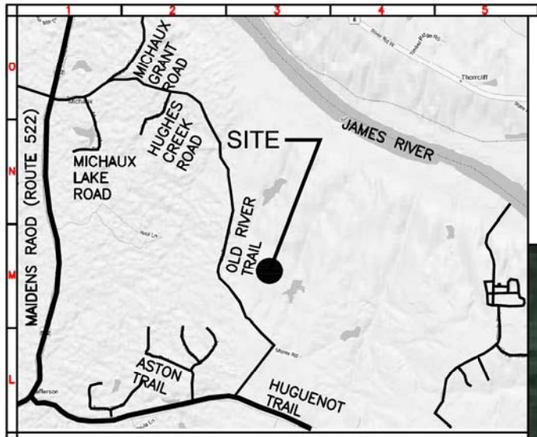
Figure 2-1 Map 4 – Natural Resources Map

Section 4
Surface Danger Zone (SDZ)-Health and Life Safety

When considering a location for construction of a firing range, the surface danger zone (SDZ) should be evaluated based on the types of firearms that are going to be permitted at the range. In the case of the Powhatan site, the FBI has indicated that they will be firing numerous types of weapons including .45-caliber pistols, M-4 (.223-caliber) rifles, and .308-long range rifles. The Department of Energy Office of Health, Safety, and Security regulate SDZ requirements (refer to Appendix A for Range Design Criteria). A copy of the United States Marine Corps Range Safety Pocket Guide (Appendix B) has also been included to demonstrate the consistency of governmental standards used for SDZ evaluation. When the SDZ criteria for the three weapons above are superimposed over an aerial image of the area surrounding the proposed firing range, it becomes immediately apparent that the SDZ encroaches on residential properties located *across* the James River, in Goochland County. The SDZ for the .308-long range rifle is over 3-miles long. Figure 4-1 and 4-2 show the limits of the surface danger zones for the weapons listed above.

While the firing range has been designed with perimeter berms to deter bullets from travelling the maximum trajectories in the SDZ, there is a potential flaw in the firing range/berm design. The range has been designed with the target area located lower than the shooter's pad. For the 300-yard range, the top of berm behind the target is located 950-ft from the shooter with a 1.7% down-grade slope. In this scenario, a level shot from the shooter would intercept the berm only 4-ft from the top of the berm, if the shooter is in the prone position and would clear the berm if the shooter were in a position with the rifle located 4-ft above the shooting pad. Additionally, it would only take a 0.3-degree margin of error in the scope calibration of the shooter's accuracy for a bullet to potentially clear the berm behind the target area.

Figure 4-1 Sheet C-1 Surface Danger Zone (SDZ) Plan



VICINITY MAP

500 0 500 1,000 1,500

Scale 1" = 500'

NOTE:

1. THIS PLAN IS FOR CONCEPTUAL PURPOSES ONLY.
2. SURFACE DANGER ZONE INFORMATION FROM RANGE DESIGN CRITERIA (U.S.D.O.E.) AND USMC RANGE SAFETY POCKET GUIDE.
3. EXISTING AERIAL IMAGE USED FROM 2010 MICROSOFT CORPORATION © 2010 NAVTEQ©, AND COURTESY OF USGS©

.308 (7.62mm)
5,288 M (17,349-FT)
APPROXIMATELY 1,000-FT
BEYOND THIS POINT
(U.S.D.O.E. & U.S.M.C.)

RIVER ROAD (GOOCHLAND)

J a m e s RIVER

M-4 CARBINE (5.56mm)
(U.S.D.O.E. & U.S.M.C.)

SECONDARY DANGER AREA

RICOCHET AREA

45-CALIBER
(U.S.D.O.E. & U.S.M.C.)

RANGE SHOOTER'S POSITION

RANGE BERM

3,437 M
(11,276-FT)

1,690 M
(5,544-FT)

SECONDARY DANGER AREA

IMPACT AREA

LIMIT OF FIRE
(WIDTH OF RANGE)

RICOCHET AREA

RANGE TARGET LOCATION

EXISTING HOUSE (TYP)

OLD RIVER TRAIL

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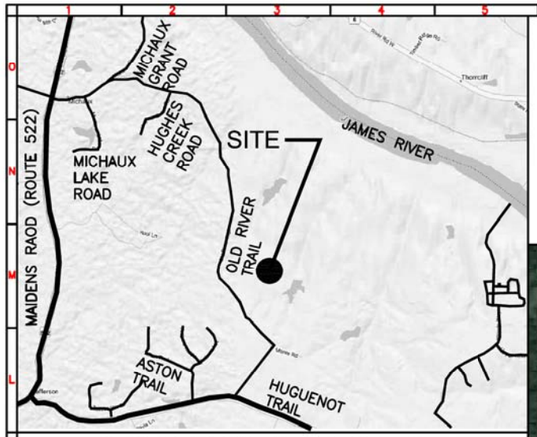
SURFACE DANGER ZONE PLAN
V.S.L.E. TRAINING CENTER
5TH DISTRICT
POWHATAN COUNTY, VIRGINIA

DRAWN BY CMS
DESIGNED BY CMS
CHECKED BY CMS
DATE 07-27-2010
SCALE 1" =500'
REVISIONS:

SHEET NO. C1

JOB NO. C1000375.00

Figure 4-2 Sheet C-1 Surface Danger Zone (SDZ) Plan (Large Area)



VICINITY MAP

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.308 (7.62mm)
5,288 M (17,349-FT)
APPROXIMATELY 1,000-FT
BEYOND THIS POINT
(U.S.D.O.E. & U.S.M.C.)

M-4 CARBINE (5.56mm)
(U.S.D.O.E. & U.S.M.C.)

SECONDARY DANGER AREA

RICOCHET AREA

45-CALIBER
(U.S.D.O.E. & U.S.M.C.)

3,437 M
(11,276-FT)

1,690 M
(5,544-FT)

RANGE SHOOTER'S POSITION

RANGE BERM

SHILOH BAPTIST CHURCH

IMPACT AREA

LIMIT OF FIRE
(WIDTH OF RANGE)

RICOCHET AREA

RANGE TARGET LOCATION

EXISTING HOUSE (TYP)

SECONDARY DANGER AREA

OLD RIVER TRAIL

RIVER ROAD (GOOCHLAND)

JAMES RIVER

Thorncliff

Maidens

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SURFACE DANGER ZONE PLAN

V.S.L.E. TRAINING CENTER

5TH DISTRICT
POWHATAN COUNTY, VIRGINIA

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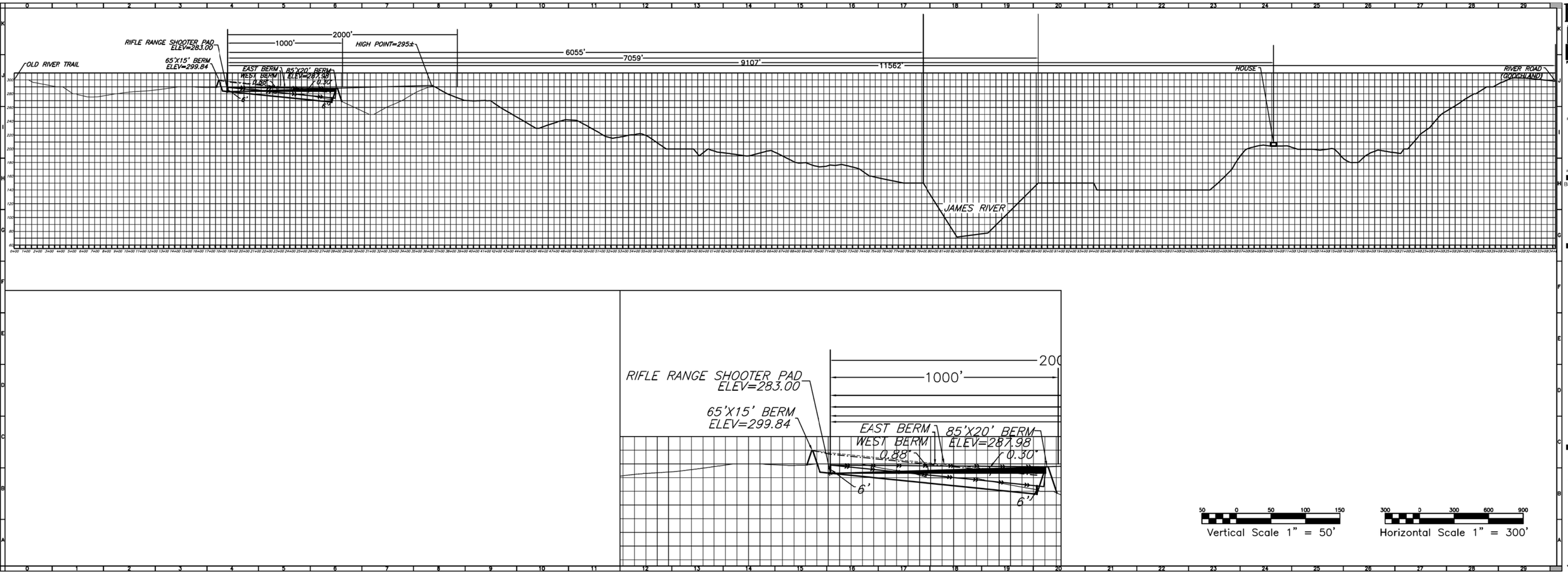
Figure 4-3 Sheet C-2 Surface Danger Zone (SDZ) Profile



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VA STATE L.E. TRAINING CENTER
GUN RANGE PROFILE
POWHATAN COUNTY, VIRGINIA

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Section 5
Noise Impacts – General Welfare

In terms of the noise impacts: the sound pressure level data produced by the noise propagation model has revealed that the expected noise level for homes located in the vicinity of the firing range will be in the 70-90 dB range. This includes the following specific locations: the inmate housing area will have a noise level of 74.6 dB, the historic Shiloh Baptist Church noise level will be 84.1 dB, and the homes located immediately behind (west) of the firing range will experience noise levels near 90dB. To provide a baseline of reference, the following is a brief list of common incidental noise levels:

- Aircraft (both idling and taxiing) 90-110 dB
- Locomotive whistle blow 90-110 dB

At the above listed levels, the incidental noise produced exceeds those levels published by HUD as acceptable. During times of operation, the general welfare of the residents in the area of the range would be severely impacted and it would present the effect of being adjacent to an airport runway while planes taxi.

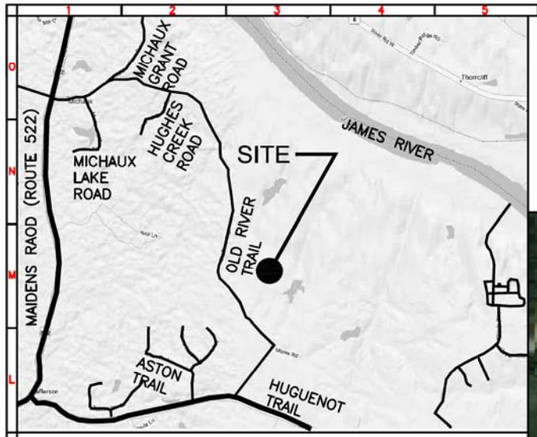
It is important to note that while the firing range is surrounded by an earthen berm for safety and noise abatement, the effectiveness of the berm is severely limited due to the design and orientation of the firing range. With the shooter being oriented south of the target and the target being oriented down-grade from the shooter, the berm acts as if it were only 4-feet tall. Given that sound propagates in all directions as it travels, the sound wave travels down the firing range as it expands and then escapes the confines of the and travels with minimal interference to the surrounding residential and agricultural areas. In essence, the design of the firing range is only minimally effective at reducing the noise that will be created, if at all.

Figure 5-1 Summary of HS-NL Data

SUMMARY OF HS-NL DATA
(NO MITIGATION / 295 - 305 BERM MITIGATION)

HS #	ELEVATION	DISTANCE TO HS	AVRG FIRE POINT ELEVATION +/- 283	EXPECTED NL @ HS NO MITIGATION	EXPECTED NL @ HS W/ 295 BERM	EXPECTED NL @ HS W/ 305 BERM
HS-1	247	6387	(-36)	74.6 dB		
HS-2	248	4864	(-35)	78.5 dB		
HS-3	267	4437	(-16)	79.7 dB		
HS-4	285	4414	(+2)	79.8 dB		
HS-5	295	4117	(+12)	80.7 dB		
HS-6	301	3189	(+18)	84.1 dB		
HS-7	292	2490	(+9)	87.2 dB		
HS-8	307	2553	(+24)	86.9 dB		
HS-9	298	1890	(+15)	90.6 dB	68.3 dB	67.0 dB
HS-10	300	2019	(+17)	89.8 dB	76.5 dB	71.9 dB
HS-11	282	2150	(-1)	89.0 dB	66.9 dB	65.7 dB
HS-12	235	2938	(-48)	85.2 dB	63.6 dB	62.4 dB
HS-13	235	2331	(-48)	88.0 dB		
HS-14	229	4235	(-54)	80.4 dB		
HS-15	283	2818	0	85.7 dB		
HS-16	268	2945	(-15)	85.1 dB		
HS-17	250	4159	(-33)	80.6 dB		

Figure 5-2 Sheet C-3 Sound Plan



VICINITY MAP

500 0 500 1,000 1,500

Scale 1" = 500'

NOTE:

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JAMES RIVER

RANGE SHOOTER'S POSITION

HS1
HS2
HS3
HS4
HS5
HS6
HS7
HS8
HS9
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17

SHILOH BAPTIST CHURCH

OLD RIVER TRAIL

ASTON TRAIL

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SOUND PLAN

V.S.L.E. TRAINING CENTER

5TH VOTING DISTRICT
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Appendix A

U.S. DEPARTMENT OF ENERGY

RANGE DESIGN CRITERIA

RANGE DESIGN CRITERIA

U.S. DEPARTMENT OF ENERGY
Office of Health, Safety and Security

AVAILABLE ONLINE AT:
http://www.hss.energy.gov

INITIATED BY:
Office of Health, Safety and Security

CERTIFICATION

This document contains the currently-approved firearms "Range Design Criteria" referred to in DOE M 470.4-3A, *Contractor Protective Force*, and DOE M 470.4-8, *Federal Protective Force*.

Barbara R. Stone
Director
Office of Security Policy

11/18/08
Date

TABLE OF CONTENTS

RANGE DESIGN CRITERIA

1. PURPOSE. This document contains design criteria for U.S. Department of Energy (DOE) live-fire ranges for use in planning new facilities and major rehabilitation of existing facilities. This document supersedes DOE M 470.4-3 Section B, Chapter II and will be approved and maintained by the Office of Security Policy, Office of Health, Safety and Security (HSS) as a stand-alone document on the HSS website.

2. PLANNING FACTORS. All applicable local, State, Federal, U.S. Environmental Protection Agency, Occupational Health and Safety Administration (OSHA), and National Environmental Policy Act requirements should be addressed and be reviewed annually (at least every 12 months) to incorporate any requirements changes that occur.

3. PLANNING OVERVIEW.

   a. General Considerations.

      (1) Live-fire range design should: (a) promote safe, efficient operation; (b) include provisions for ease of maintenance; and (c) be affordable to construct and maintain.

      (2) Live-fire ranges should be designed to prevent injury to personnel and to prevent property damage outside the range from misdirected or accidental firing and ricochets. They should also be designed to direct ricochets away from the firing line inside the range.

      (3) An open range may be established provided that enough distance and land area available to allow for surface danger zones (SDZs) appropriate for the weapons to be used. Lack of SDZs may require baffled ranges. Extreme weather conditions may necessitate indoor ranges.

   b. Type of Range.

      (1) Range requirements should be considered when determining the type and size of the range and the material to be used.

      (2) The range should be suitable for training and qualifications for all courses of fire used on the site as set forth in the HSS-approved Firearms Qualification Courses.

      (3) The range should be designed for shooting day and reduced-lighting DOE firearms courses, moving targets, multiple targets, and advanced shooting courses that may be required by the site.

      (4) When determining whether the facility will be an indoor, open outdoor, partially baffled, or fully baffled range, the decision-making process should include site weather conditions, available land, available funding,

and environmental, safety, and health considerations. The following additional factors should be considered.

(a) How many shooters must be accommodated?

(b) Will emphasis be on training or competitive activities?

(c) What types of firearms and range of ammunition will be used? (See Table 1.)

(d) Will the facility be used exclusively by DOE or will it be open to other organizations?

(e) What special uses will be made of the facility, e.g., advanced training, special weapons, or explosives?

(f) What lighting will be required, and what lighting is desired?

(g) What administrative space will be needed?

(h) What types of target mechanisms will be used?

(i) Will spectator safety areas be needed?

(j) What types of acoustics will be needed?

(k) How will lead contamination be controlled?

(l) Where will bullet traps be needed?

(m) Where will firearms cleaning and maintenance be performed?

c. Site Selection Preparation. The site selected should accommodate the required facility. It should meet acceptable standards for safety and have sufficient space, access, and acceptable zoning and construction costs. Land acquisition costs, future land values, and possible restrictions should also be examined. To ensure the project is feasible the following data should be considered.

(1) Documents. Copies of specific site, environmental, and construction criteria; applicable mandated regulations from the State, county, and local authorities; copies of ordinances, zoning regulations, soil conservation standards, health department requirements, and any other regulations that may pertain to the project should be obtained.

(2) Alternate Sites. Identify alternate sites, because one or more of the potential sites may be unsuitable or construction costs may be prohibitive.

(3) Technical Data. Gather technical data relevant to each site including zoning maps, aerial photographs, topographic maps, and onsite ground and aerial information.

d. Considerations. The criteria to be considered in this process are:

(1) environmental restrictions, e.g., Endangered Species Act, Wilderness Act, and air and water pollution criteria;

(2) access, e.g., is it adequate or should a roadway be constructed to the site;

(3) construction cost, e.g., berms, baffles, barriers, earth moving;

(4) other restrictive Federal or State statutes and local ordinances; and

(5) community growth, especially in areas where urban growth is rapid. Escalating property values may make it unwise to construct in a particular area.

e. Preliminary Design Stage. The following preliminary design process is to be followed.

(1) Prepare:

(a) a preliminary layout sketch of each site;

(b) a draft document, which should include specifications for applicable zoning, building codes, environmental, safety, and health considerations, and other pertinent restrictions;

(c) alternative preliminary site plans showing different range layouts;

(d) a planning cost estimate; and

(e) a risk analysis report.

(2) Submit all zoning and building permit applications for approval. Be prepared, via the draft document, to present and, if necessary, defend the proposal at public hearings before zoning boards, health officials, and other governmental bodies involved in issuing permits.

f. Final Design Stage.

(1) The preliminary site plans include a layout of the proposed range with its accompanying safety fan in a cross section and top view.

(2) The range master/manager, training manager, safety manager, industrial hygienist, appropriate operating personnel and public works engineer

should review the design requirements during the planning phase, before the construction drawings are started, and during the construction phase.

4. OUTDOOR RANGE DESIGN.

a. Site Selection.

(1) Outdoor range sites should be remote from other activities but accessible by road. SDZs should not extend across traveled roads, navigable waterways, railroads, or other areas.

(2) To protect against unauthorized access, SDZs should be controlled while firearms are being discharged. To prevent future encroachment, SDZs should be recorded on site maps.

(3) If other methods to control access to SDZs are not effective, then the zones should be fenced in. Natural barriers around the site, e.g., rivers, hills or a large drainage channel may be used to prevent encroachment and will ensure privacy. The best site is one with a natural backstop for projectiles to reduce the cost of constructing earth impact berms and to provide natural sound abatement.

(4) Outdoor ranges should be oriented to eliminate firing into the sun. The range should be oriented to the north or slightly to the northeast. The ideal direction is between due north and 25° northeast.

b. Range Planning.

(1) Firing into upward sloping land and land with natural backstops of hills or mountains is recommended.

(2) Firing platforms, access roads, and targets should be elevated above the flood level.

(3) The line of fire in rough terrain should be perpendicular to high ground. The line of fire on flat terrain should be free of knolls, ridges, and trees that reduce visibility.

(4) Known distance ranges should be as flat or evenly graded as possible. If the grade between the firing points and target does not exceed 2 percent, then the firing points may be below the target.

(5) Roads used for setting and servicing targets in impact areas and for maintenance of earth berm may be graded pathways. Roads in areas not subject to disturbance, e.g., vehicle parking areas, and roadways behind firing lines or out of range of weapons, should be designed for anticipated vehicle weight and usage.

(6) The ground between the targets and firing line should be free of any hardened surface (smooth-surfaced walkways excepted) such as rocks or other ricochet-producing material.

(7) The surface may be sodded or planted with low-growing ground cover.

(8) The surface should be smooth, firm, and graded to drain away from the targets. A slight side-to-side grade of 1 percent to 2 percent should be provided for storm water runoff. For baffled ranges, the lateral slope should not exceed 2 percent because of the geometry of the baffle system.

(9) The overall size will be governed by the range distance and number of firing positions.

(10) Range distances from the firing line to the target are determined by the approved DOE qualification courses of fire for all weapons available for use by Protective Force (PF) personnel and by site-specific training courses of fire. The distances from the firing line to the target should be accurate to +.01 percent. It is important that any inaccuracy in the firing line-to-target distance is a greater, rather than lesser, distance (e.g., 101 yards for a 100-yard range instead of 99 yards).

(11) Shooters should have secure footing.

c. Surface Danger Zones. SDZs should be established to contain all projectiles and debris caused by firing ammunition and explosives (see Table 1). SDZ dimensions are dictated by the types of ammunition, types of targets, and types of firing activities allowed on the range. A basic SDZ consists of three parts: impact area, ricochet area, and secondary danger area (Figure 1). Figures 2 through 6 illustrate the application of the basic parts in the design of SDZs for various kinds of range activities.

(1) The primary danger area established for the impact of all rounds extends 5° to either side of the left and right limits of fire and downrange to the maximum range of any ammunition to be used on the range.

(2) The ricochet area is 5° to either side of the impact area and extends downrange to the maximum range of any ammunition to be used on the range.

(3) The secondary danger area is that area paralleling, and 100 yards outside of, the outermost limits of the ricochet area and extending downrange to the maximum range of any ammunition to be used on the range.

(4) Boundaries of SDZs must be posted with permanent signs warning persons of the danger of the live-fire range and prohibiting trespassing. The signs must be posted in a way that will ensure a person cannot enter

the SDZ without seeing at least one legible sign (i.e., usually 200 yards distant or less).

(5) Limit of fire markers, both external and internal, must be placed to denote right and left limits of fire. Where cross firing is to be conducted, internal limit markers must be emplaced to denote internal right or left limits of fire from specific firing positions.

(6) Ranges may be located parallel to one another if in compliance with Figure 19 for separation.

(7) When there is insufficient distance to lay out a new range with the required SDZ or utilize other ammunition with a maximum range that does not exceed the SDZ, engineered or administrative controls can be used to control firing on that range. Permission to deviate from established SDZ requirements must be granted by the DOE cognizant security authority and supported by a safety risk analysis.

(8) Administrative controls such as use of the low-ready position or engineered controls such as muzzle traverse/elevation limiters can be used to control the firearm. Natural terrain such as a mountain or a hill provides an excellent backstop for firing. The terrain should be high enough to capture rounds fired at up to a maximum 15° muzzle elevation.

(9) To change the size and shape of an SDZ, baffles may be installed. Partial and full baffle systems consist of the following components: overhead baffles, a canopy shield over firing points, bullet impact berm, and side berms, sidewalls, or side baffles. A fully baffled range must be constructed so all direct fire can be contained within the range (see Figures 7 and 8).

d. Support Facilities. Range planners should consider the site-specific need for the following range support facilities.

(1) Targets.

(2) Target storage.

(3) Bunkers, trenches, and protective barriers for personnel protection.

(4) Range control towers.

(5) Toilets.

(6) Range poles, banners, markers, and signs.

(7) Communication systems.

(8) Access and range roads.

(9) Parking areas.

(10) Potable water.

(11) Target maintenance.

(12) Ammunition storage.

(13) Power.

(14) Sewer.

(15) All other necessary utilities.

Table 1. Maximum Range of Small Arms Ammunition

Maximum Range of Small Arms Ammunition	
Caliber	**Maximum range of small arms ammunition (distance in meters)**
.22 long rifle	1,400
.38 revolver	
Ball, M41	1,600
Ball PGU-12/8	1,900
.40 pistol	
Ball	1783
JHP	1908
Frangible	1000
.45 pistol	1,500
.45 submachine gun	1,600
.357 magnum	2,160
9mm pistol	1,740
9mm submachine gun	1920
.44 magnum	2,290
.50 machine gun	
Ball, M33	6,500
AP, M26	6,100
12 gauge shotgun, riot 00 buckshot	600
.30 rifle and machine gun	
Ball, M23	3,100
AP, M2	4,400
.30 carbine	2,300
5.56mm rifle	
Ball, M193	3,100
7.62mm rifle and machine gun	
Ball, M80	4,100
Match, M118	4,800
40mm	
M79	400
Mk-19 40mm	2200

e. Design Criteria.

(1) Firing Line Items. Provide the following components.

(a) Floor Surface. The surface should be smooth, firm, and graded to drain away from the targets. A slight side-to-side grade of 1 percent to 2 percent should be provided for storm water runoff. Transverse firing line grading should match target line transverse grading. The distance between the firing line(s) must be sufficient to support the type of training conducted. Firing lanes must be clearly marked on the surface to match the targets. Depending on the number of personnel to be supported and the funds available, the following surfaces should be considered:

1 ground firmly compacted with mown grass;

2 sand or fine gravel;

3 wood decking of sufficient thickness and support to prevent movement; and

4 concrete topped with appropriate cushioning material.

(b) Overhead Containment. On partially and fully baffled ranges, a ballistic canopy (see Figure 9) should be provided over all locations where a weapon may be expected to be discharged (firing line, by definition). Figure 9 represents one construction approach, but the canopy must contain the direct fire effects of the most energetic round fired on the range. This canopy should begin at least 3 feet behind the firing line. General structural requirements may dictate more distance. The canopy should extend forward a minimum distance of 13 feet minimum, which will work geometrically with the first overhead baffle to prevent a weapon from firing directly out of the range (see Figures 16 and 17). The canopy should be constructed of ballistic material with sacrificial cladding as described below. Sound reduction ceiling waffles should be considered. Weather roofing is required above the ballistic material and it must slope sufficiently to drain.

(2) Firing Point. The depth of the firing point is determined by the shooting activity; e.g., rifle firing requires more depth than pistol firing.

(a) The minimum depth of the firing point is the area required for the shooter, shooter's equipment, scorers, and range officers. For example, a pistol range might have a firing line approximately 6 to 10 feet deep, while a rifle range would have a firing line up to 20 feet deep. This variation is based on available space, type of

shooting, size of target frames and carriers, and the spacing of target frames or carriers.

(b) For rifle ranges, each firing point should be 9 feet wide (see Figure 10). Firing lanes for pistols and shotguns should be 5 feet center to center (see Figure 11).

(3) Ballistic Material. The purpose of this material is to absorb, deflect, or fragment projectiles. Material for baffles on partially and fully baffled ranges is shown in Figures 12 and 18. Wood that is used should be of middle grade exterior timber or plywood. Timber in contact with the ground must be pressure-treated for this purpose. Avoid exposed connectors if possible. Refer to Table 2, Thickness of Material for Positive Protection Against the Caliber of Ammunition Listed, for the thickness of various materials.

(4) Sacrificial Cladding. Provide ¾-inch thick plywood with a ¾-inch air gap on any surfaces (baffles, wing walls, metal connectors, etc.) that are within 11 yards of the firing line to prevent back splatter.

(5) Firing Line Cover Material. The firing line should be covered to protect the shooter and allow activities to be held regardless of the weather. On ranges with several firing lines, the cover is generally installed at the longest firing distance. The firing line covers described below are for shelter only and should not be confused with the ballistic firing line canopies required on baffled ranges. Material that can be used for firing line covers includes wood, concrete, steel, and plastic. Most covers are constructed from wood products and are a shed or gable roof design. In some cases, corrugated metal or fiberglass roofing material can actually increase sound levels at the firing line and in areas around the range. Therefore, to reduce noise, corrugated metal or fiberglass roofing material should not be used unless it is acoustically treated. The structure should be designed to include the following:

(a) The shed roof should have a 6-inch (15cm) cavity filled with fiberglass insulation (or equivalent) and be enclosed on the bottom with 19mm (¾-inch) plywood or insulation board. Although this will not provide a completely effective sound barrier, sound waves will strike and penetrate the inside layer of plywood, and the sound will be reduced;

(b) A plywood shed roof should have a 15cm (6-inch) hollow core enclosed with a small grid mesh screen and a six-mil polymer barrier to retain the insulation. The intervening space should be filled with blown-in insulation to trap sound waves and reduce the drum effect of an open roof; and

(c) A gable roof has a large hollow area above the joists; however, additional sound damping materials should be installed to reduce the drum effect and the sound pressure level as they are reflected onto the firing line area. The underside of the roof surface will require a minimum of 4 inches of insulation to fill in between the rafters and a minimum of 3 inches of insulation above the ceiling and between the joists. This will reduce the drum effect caused when sound waves strike surface material (e.g., corrugated metal) and will absorb a portion of the reflected sound waves.

(6) Surface Material. Positions should be hard-surfaced (e.g., concrete, gravel, wood, asphalt, or sod).

(a) For ranges where prone shooting is conducted, gravel or similar materials may cause difficulty for the shooter. When the surface material is concrete or asphalt, shooting mats or padding will be required when the kneeling or prone positions are used.

(b) For ranges with multiple firing lines, hard-surfaced firing lines located downrange of another firing line should be recessed or shielded from bullet impact to avoid ricochets off exposed edges.

(7) Landscaping. The site should be landscaped to provide for erosion control, noise abatement, maintenance, appearance, fire protection, and safety.

NOTE: Any landscaping will complicate the removal of lead in the berms, especially on impact surfaces, and will create higher maintenance costs.

(a) Berms should be planted with grass to prevent erosion. Ground cover is acceptable on existing berms that have been maintained and where erosion is not a problem.

(b) When grass is selected as a ground cover, it should be appropriate for the geographic area and should readily grow and provide good coverage. The degree of shading caused by overhead baffles will determine the type of grass for the range floor. Use grasses and cover for earth berms that will not be accessed by moving equipment so that natural growth heights will be acceptable. In areas where the soil is poor or extremely sandy, plants such as Bermuda grass, ice plant, or vine root can be used to control soil erosion.

(c) Heavy landscaping may be used to cut down on noise transmission. Plants and trees may be planted behind the firing position shelters to alleviate noise transmission problems.

Soundproofing the firing line structures should be considered in problem areas. Trees should be kept away from firing lines to allow range control officers to see all shooters.

(d) For windbreaks, trees may be planted along the length of the range with partial side berms or wing walls where strong prevailing crosswinds are problems to shooting accuracy.

(e) Densely planted rows of fast-growing, compact, and thorny shrubs may be planted below the trees at ranges with partial berms or wing walls to abate noise, prevent encroachment, and alleviate crosswind problems.

(8) Target Line and Mechanisms. Components must be as follows.

(a) The target line should be a minimum of 30 feet from the toe of the impact berm. The distance between targets must be the same as the distance between firing positions.

(b) Target line bases must match grading with the firing line. Mechanical target support bases must be protected from the direct line of fire. They may be buried flush with the ground or placed behind a protective wall. Note that a small raised earth berm at this location generates significant ricochet. The complexity of the mechanism will dictate the protection requirement. See Figure 13 for wall or trench protection of high cost target line mechanisms.

(c) Target supports can be made of steel angles and channels, PVC pipe or wood. Do not use metal parts within 33 feet of the firing line where direct fire strikes are anticipated. Discharging weapons close to metal surfaces is extremely dangerous. Present the smallest surface area that is structurally sound to the line of fire to minimize ricochet. Design the target holders for easy and inexpensive replacement. Portable, self-supporting 2- by 4-inch wood frames or 2-inch by 2-inch wood plank placed into buried PVC pipe work well on simple ranges. The full face of the target must be visible to the shooter.

(d) Turning targets and the display time are at the discretion of the user. Commercially available, electrically motorized target carrier and electronic scoring systems should be considered where economically feasible.

(e) On open ranges, a single target line with multiple firing lines is preferred. On partially or fully baffled ranges, in most instances, a single firing line with multiple target lines will produce the most cost-effective range because of the firing line canopy. An

extremely advanced target mechanism may be significantly more expensive than multiple canopies used to shift the advantage.

(9) Impact Structures. The structure varies depending on the type of range. Natural terrain such as a mountain, cliff, or steep hill may be incorporated into impact structures provided the completed structure complies with the minimum requirements of this Section. Acceptable structures by range type are listed below.

(a) For open ranges, the top elevation of the earth impact berm should be 26 feet above the range surface for ranges 100 yards long or longer and 16 feet above the range surface for ranges 50 yards long or less. The impact berm should extend 50 yards beyond where the target line ends for 100-yard-long ranges and 16 feet, or until joining with the side containment, if provided for ranges 50 yards long or less.

(b) The suggested elevation may be met by designing a combination of earth berm and vertical baffle (see Figure 14). The earth berm portion should have a top elevation of 16 feet above the surface of the range. The vertical baffle should be constructed of ballistic material and designed to withstand local seismic and wind loads. This combination arrangement would reduce the footprint and the amount of material in the earth berm.

(c) The preferred slope of the impact berm face is 1 to 1 or steeper. The steeper the slope, the more likely the berm is to absorb projectiles. The top should be 10 feet wide. The impact slope should be constructed with a 3-foot layer of easily filtered soil (to reclaim the lead projectiles) free of boulders, trees, rocks, stones, or other material that will cause ricochet. The rear slope should be appropriate to the native soil and maintenance requirements.

(d) For partially and fully baffled ranges, the top elevation of the impact structure will vary depending on the overhead baffle and impact structure arrangement. The impact structure for a partially baffled range can be: standard impact berm, bullet trap, or hybrid. For fully baffled ranges, the impact structure must be a bullet trap. In all instances, the impact structure must connect to the side containment. The top of the berm should be at an elevation 5 feet above the point where the highest line of direct fire can strike the berm.

(e) Outdoor bullet traps can be constructed by placing the last vertical overhead baffle over the last target line and placing a sloped baffle to connect from the top of the earth berm to the back of the last vertical baffle. The bottom of this lower-sloped overhead baffle

should be 2 feet above the highest point on the berm where direct fire might strike. See Figure 15 for material and construction details. Rainfall runoff from the sloped baffle onto the berm must be considered.

(10) Side Containment. For partially and fully baffled ranges (Figures 7 and 8), the top elevation of the side containment must geometrically mate with the overhead baffles to be high enough to prevent any direct fire from exiting the range. Full-side height containment should extend 3 feet to the rear of the firing line. Locate the side containment at least 10 feet outside of the centerline of the outermost firing lane. Construction may be in the following forms.

(a) Earth Berm. Construct earth berms to an inside slope of 1 to 1.5. If native soil characteristics will not produce a stable slope at this angle, provide geotechnical fabric reinforcement in the fill. The top width of the berm should be at least 10 feet. No rocks are permitted in the top 3 feet of the inside surface. Generally, earth berms cannot be used on partially or fully baffled ranges; however, earth berms are permissible if the firing range is small and the overhead baffle and berm geometry intercept ricochets.

(b) Continuous Walls. Construct continuous walls of ballistic material to withstand local wind and seismic loads. Provide sacrificial cladding to 13 feet forward of the firing line and 3 feet behind the firing line. Continuous walls are preferred for fully baffled ranges.

Table 2. Thickness of Material for Positive Protection Against the Caliber of Ammunition Listed

Cover material	Caliber and thickness required to stop penetration		
	5.56 mm	7.62 mm and Cal. 30	Cal. 50
Concrete (5,000 lbf/in^2)	5 inches	7 inches	12 inches
Gravel-filled concrete masonry units	8 inches	12 inches	24 inches
Broken stone	14 inches	20 inches	30 inches
Dry sand	16 inches	24 inches	32 inches
Wet sand	25 inches	36 inches	48 inches
Oak logs (wired)	28 inches	40 inches	56 inches
Earth			
Packed or tamped	32 inches	48 inches	60 inches
Undisturbed compact	35 inches	52 inches	66 inches
Freshly turned	38 inches	56 inches	72 inches
Plastic clay	44 inches	65 inches	100 inches
NOTE: Figures are based on new material. Degradation may occur over time.			

(c) Wing Walls. Wing walls (side baffles) are discontinuous side protection set at 45° to the line of fire. Locate the wing walls so that they are overlapped by 6 inches based on any line of fire that may strike them. Construct the wing walls of ballistic material to

withstand wind and seismic loads. Additionally, provide sacrificial cladding on wing walls closer than 30 feet to the firing line.

(d) End Walls. End walls may be constructed at the firing lane edge on the firing line in lieu of extending side containment 3 feet behind the firing line. Walls should be long enough to close off any line of sight between the end of the side containment and the rear 3 feet mark. The end walls should be constructed of ballistic material with sacrificial cladding extending from the canopy to the firing line surface.

(11) Overhead Baffles. Overhead baffles must be located so that no direct fire can exit the range from any firing position. The first overhead baffle must be geometrically coordinated with the firing line ballistic canopy (see Figure 9). The top elevation of the top of each following baffle should be 6 inches higher than a line of fire that just clears beneath each preceding baffle (see Figure 16). Overhead baffles should be the same height and spaced apart down range to achieve the required geometry (see Figure 17). The last baffle should be placed so the line of fire will strike the impact structure no higher than 5 feet below the top elevation of the structure. On a fully baffled range, the last overhead baffle must be over the last target line.

(a) On partially baffled ranges, overhead baffles must extend laterally to within 1 foot of the side containment. On fully baffled ranges, the overhead baffle must tie into the side containment.

(b) The vertical dimension of an overhead baffle when it is vertical varies with the number and spacing of the baffles. Normally, the height is between 5 and 8 feet when considering structural support size and costs.

(c) The baffles must be constructed of ballistic material. Baffles within 11 yards of the firing line should be covered with sacrificial cladding. See Figures 12 and 18 for possible configurations.

(d) Space the structural columns as far apart laterally as possible to open firing lanes. If possible, do not construct columns within the range. Design columns or beams to withstand local wind and seismic loads, and provide protective steel plate on the faces of the columns exposed to the firing line in accordance with Figures 12 and 18. Provide sacrificial cladding if the column is within 10 yards of the firing line. Overhead baffles may be placed on a flatter slope and overlapped to function as firing line canopies if multiple firing lines are to be used (see Figure 17). This arrangement is cost-effective for baffled combat lanes.

5. INDOOR RANGE DESIGN.

a. Use of Indoor Ranges.

(1) Indoor ranges must be designed so projectiles cannot penetrate the walls, floor or ceiling, and ricochets or back splatter cannot harm range users. Considerations should be made for cleaning of all surfaces and handling of hazardous wastes.

(2) Lead exposure requirements must be reviewed for applicability.

b. Site Selection.

(1) Walls and Partitions. Indoor ranges must incorporate walls and partitions capable of stopping all projectiles fired on the range by containing or redirecting bullets to the backstop.

(2) Existing Buildings. If there are existing drawings of the facility, copies should be obtained from the original owner, architect, engineer, builder, or building permit. If original drawings of the building are not available, a sketch can be made of each floor of the building with a special emphasis on the load-bearing walls. The following considerations should be used when making the initial evaluation of an existing building.

(a) General Construction. Buildings constructed of wood products should be avoided. Modifications to reinforce the structure to support metal backstops or to reduce fire hazards may not be cost-effective.

(b) Exterior Walls. The type of exterior wall construction (e.g., masonry, wood, concrete, metal, combination, other) should be identified. Masonry buildings should be given primary consideration, especially those constructed on concrete slabs.

(c) Floors, Walls, and Ceilings. Floors, walls, and ceilings must be able to contain a bullet fired as well as the sound.

1 The ideal wall is made of poured concrete a minimum of 6 inches thick.

2 To aid in range cleaning, concrete floors should be finished so they have a nonporous surface.

3 Ceilings should be 8 feet high and enclosed to reduce air turbulence created by ventilation systems.

4 Evaluate the structural support designs of older buildings for their ability to withstand new loading. Original design

considerations usually do not allow for installing heavy backstops and other range equipment.

5 To decide if modifications are necessary, slab buildings must be analyzed carefully to determine the capacity for floor loading. If there are no floor drains and it is economically feasible, modifications should also include adding one or more floor drains.

6 Ceiling joists may require strengthening to support baffles and shielding material.

(d) Electrical. Electrical needs may require the installation of heavy-duty wiring both internally and externally to accommodate the added power needs of range ventilation, heating, lighting and target-carrier mechanisms.

(e) Plumbing. Plumbing does not usually require major modifications; however, heavy metals may be prohibited from area wastewater treatment collection systems. Therefore, an approved filtration system may be necessary for disposal of hazardous waste material; e.g., lead.

(3) Precast Buildings.

(a) Precast concrete companies can provide complete precast buildings (job site-delivered) if engineering specifications for steel placement are provided on a set of plans (drawings) for the proposed building.

(b) Precast assembly allows for installation of a roof design more suitable for an indoor range. Gabled or hip roof designs should not be used.

(c) Hollow, precast concrete panels provide an option to bar joists, eliminating bullet ricochet or splatter. A flat bar joist design is the recommended alternative to hollow, precast concrete panels.

(d) The flat roof design also provides support for heating, ventilating, and air conditioning (HVAC) equipment outside of the range, which saves space and reduces cost.

(4) New Construction. New indoor construction projects require the same guidelines as existing buildings; however, they offer the advantage of building a structure specifically for an indoor shooting range.

c. Range Planning. Design work for ventilation, wall structures, floors, ceiling, acoustics, backstops, and lighting will depend on how the range will be used.

(1) A determination for the type of building required includes the following considerations.

(a) Can the range be built in an existing building or is a new one required?

(b) How large should it be?

(c) How many shooters will it be expected to serve?

(d) Will it be used for competition?

(e) Should space be allowed for classrooms?

(f) How much will the facility cost?

(2) The planning process should include:

(a) obtaining ordinances, zoning regulations, building codes, soil conservation regulations and other information pertaining to legal requirements;

(b) for evaluation, identifying a site for a new building or several existing buildings that may have the suitable design characteristics; and

(c) gathering other technical information relevant to the project. This information includes zoning requirements, onsite information, and range design criteria. Local zoning codes or health department regulations normally will provide answers or solutions on how the project is to be handled.

d. Design Criteria. Based on the site selected, type of shooting, number of users, and site layout, the next step is to design the facility by preparing detailed drawings showing specifications and necessary dimensions. The four main considerations for indoor ranges are shooter needs, type of shooting activity, number of firing points, and number of users. Special consideration should be given to ventilation, lighting, safety baffles, and backstop design. The following standard and optional features for indoor ranges should be considered.

(1) Backstops and Bullet Traps.

(a) The design of a backstop or bullet trap is a contributing factor to the service life of the unit. Steel should be installed according to

the type of ammunition to be used and to proven angle configurations.

(b) The design criteria should be based on the planned use of the facility. Metal plates selected for use in a backstop or trap must resist repeated stress according to the degree of stress applied. Necessary characteristics are resistance to abrasion, resistance to penetration, surface hardness, thickness, and alloyed strength to resist metal fatigue.

(c) The main backstop is generally a fabricated steel plate or series of plates used to stop bullets fired on a range. Backstop configurations and plate thickness will change according to type of shooting activity.

(d) Steel backstops with sand or water pits are common; however, a few indoor ranges use earthen or sand backstops.

CAUTION: Earthen or sand-filled backstops are not recommended because they can create health hazards for maintenance workers from silica and lead dust. They also cause excessive wear on ventilation fans.

(e) Backstops must extend from side to side and from ceiling to floor to protect the end of the range completely from penetration by direct bullet strike and prevent ricochets, back splatter, and splatter erosion of side walls.

(f) Four basic backstop and bullet trap designs are used for indoor ranges: Venetian blind, escalator, Lead-a-lator®, and the angled backstop (45°) back plate. Other backstop designs exist and should be researched for applicable use.

1 Venetian Blind Backstop. Requires less space, but without proper installation and regular maintenance it can cause back splatter problems from exposed edges of each main segment of the backstop. Keeping the exposed edges ground to original specifications is time-consuming, difficult, and requires skilled personnel.

a To control back splatter, a curtain should be hung in front of the backstop. Tests have been conducted on materials including canvas, burlap, cardboard, insulation board, and synthetic rubber. Properly installed, these materials effectively stop back splatter. Walls using insulation board or a synthetic rubber curtain are best.

b The main advantage of the venetian blind backstop is minimal space requirements. While an angled plate or an escalator will use 14 feet of space, the venetian blind uses only 5 feet.

2 Escalator Backstop. Sets up with flat steel plates laid out on a framework sloping away from the shooter. Between each series of plates, an offset allows a bullet sliding down the facing surface to drop into a hidden tray for easy cleanup. At the top or back of the backstop, a swirl chamber is provided to trap the bullets or bullet fragments as they exit the backstop surface. Once the bullet's flight ends in a spin-out chamber, the bullet or pieces fall into a cleanup tray.

3 Lead-a-lator®. A variation of the escalator-type backstop that uses a curved instead of flat piece of steel. The surface is concave and operates so that a bullet will follow the contour of the surface into a dry lead spinout chamber where it is trapped.

4 Angled Backstop (or 45° Inclined Plates). Uses a sand or water trap and has been the traditional alternative for indoor ranges.

a The angle of the plate should never exceed 45° from the ground. The 45° plate and pit backstop is relatively inexpensive, but there are several disadvantages. Sand traps require frequent cleaning to remove bullet fragments. Cleaning operations require workers to wear high-efficiency particulate air (HEPA) filter masks if material is removed dry. It is best to dampen the sand trap material before and during cleaning operations to eliminate dust. To maintain a healthier internal environment, frequent removal, disposal, and replacement of lead-laden sand is required. The surface should be continually raked to keep the sand level and to guard against splatter as lead buildup occurs.

b The cleaning operations are easier when a water trap is used. However, a water trap requires chlorine and other chemicals to retard algae growth and antifreeze in colder months to prevent freezing. Installing a water pit requires a different approach to foundations and footings, especially in areas affected by earthquakes or freezing.

(2) General Range Cleaning. Both dry and wet methods can be used to clean the range. The method selected depends on the frequency of use. The wet method is preferred when floor drains are available, and keeping materials wet during cleaning operations reduces or eliminates release of microscopic dust particles. When dry methods must be used, workers must use the appropriate personal protective equipment (PPE) that has been established by local industrial hygiene personnel. After cleaning operations are complete, workers must shower and have work clothing laundered.

(3) Backstop Steel Plate Specifications.

(a) Steel plates supported by concrete or masonry should be anchored by expansion bolts or toggle bolts, as suitable for construction, with flush countersunk heads not more that 12 inches on center of all edges of each plate. Joints and edge lines should be backed with continuous ½-inch thick plate no less than 4 inches wide. Bolts should pierce both the facing and back plates. Expansion bolts should penetrate concrete not less than 2 inches. Steel plates must have milled edges at all joints.

(b) Joints must be butted flush and smooth. After the plates are erected, they must not have any buckles or waves. Exposed edges must be beveled at 42° to a fillet approximately ½-inch thick. There must be no horizontal joints in any steel plate work.

(c) Welding must meet the American Welding Society code for welding in building construction. Steel plates joined at, and supported on, structural steel supports must be spot-welded to steel supports not more than 6 inches on center.

(4) Baffles, Deflectors, and Shields. Baffles on indoor ranges protect lighting fixtures, HVAC ducts, ceilings, and target carrier apparatus. Baffles are designed to protect against the occasional errant bullet but not for repeated bullet strikes.

(a) To cover or protect vulnerable ceiling areas or range fixtures, baffles must extend the entire width of the range and downward. Spacing of baffles on a 50 to 75 feet range depends on the ceiling design. Range distance (firing line to target line) and height are factors. Ceilings must be impenetrable.

(b) Baffles or deflector plates must be used when modifying an existing building, especially in a building constructed of wood. This will prevent bullets from escaping or penetrating. Baffles should be a minimum of 10-gauge steel covered with a minimum of 1 inch of soft wood to prevent back splatter. The wood traps the

projectile, whereas bare steel redirects it downward into the range area. A wood surface must be applied to overhead baffles, because ranges with untreated baffles usually show significant damage to concrete floors and often complete penetration through wood floors.

(c) Baffles should be installed at a 25° angle as measured from the horizontal plane of the ceiling. The baffle size and placement depends on what surface areas require protection. For example, ceiling baffles are wider than side baffles. See Figures 14 and 15 for baffle placement.

(d) Unlike baffles, deflectors are installed vertically and horizontally to redirect wide-angle shots into the backstop area. Deflector shields protect pilasters, leading edges of sand traps, bottom edges of backstops, doorways, windows, ventilation registers along the wall, etc. Deflectors are not covered with wood generally, but may be. These devices are also installed at a 25° angle either to the wall surface or floor. See Figure 16 for deflector installation.

(e) To protect ceiling areas, special impenetrable shields are installed above the firing line, especially in wood frame buildings.

1 Shields should extend the entire width of the range and 12 feet forward of the firing line. Floor shields may be required on wood floors.

2 Shields must be constructed from metal sheets according to planned use. For example, 10-gauge steel covered with a minimum of 1 inch of soft wood is effective in stopping most pistol calibers.

(5) Floors, Walls, and Ceilings. Indoor range facility floors, walls, and ceilings must be impenetrable; therefore, an existing building must have a structural analysis to determine loading factors that may exceed original design specifications. Wooden buildings may require modifications to support the increased weight. Specifications for new construction call for either poured-in-place concrete, pre-cast concrete, or dense masonry block. Solid cinder block should be used in place of hollow-core block. Specifications for modifying existing buildings call for adding additional materials to prevent bullet escape, which can be done with wood and steel laminated shields. Laminated shields can be constructed onsite by placing sheet-steel or steel plates between two sheets of ¾-inch plywood. While this method is more expensive than the extended booth design, it allows for an open firing line and better visibility for the range officer. Walls should be treated beginning 3 feet to the rear of, and extending forward of,

the firing line until all vulnerable surfaces are protected. Acoustical material should be applied to the surfaces to aid in sound control.

(a) Floors. The range floor should be constructed by using a single pour and a fine, uniform-aggregate mix of concrete. Reinforcement should be No. 4 steel rods placed 12 inches on center along with 6- by 6-inch 8/8-gauge welded wire fabric. This may vary according to soil conditions. Very large floor areas may require two or more pours with expansion joints between each slab.

1 The floor should be designed to slope down toward the target line, beginning at the firing line, ¼-inch per foot.

2 The floor should be no less than 4 inches thick.

3 Floor size is governed by design. Larger size will result in higher costs for ventilation, lighting, heating, and overall building design. The decisions should be based on expected number of users versus overall cost.

(b) Floor Guards. Floor guards are provided to protect leading edges or protrusions, e.g., drains, traps or other protrusions from the floor area. Floor guards are designed to redirect errant bullets into the backstop area, which minimizes range damage.

1 Floor guards are constructed from 10-gauge steel and may be covered with wood.

2 Floor guards are installed horizontally along the floor surface parallel to the firing line.

3 Floor guards typically slope away from the firing line at a 25° angle to the horizontal.

4 Floor guards should extend only as high as necessary to protect exposed surfaces.

(c) Floor Drains. Floor drains should be constructed of cast iron soil pipe. The drain pipe should be attached to a lateral drain located 1 foot forward of the backstop floor guard. The drain pipe must lead to a filtration system approved by the cognizant environmental, safety, and health organization on the site.

(d) Walls. Poured concrete or masonry is preferred for wall construction, but wood may be used. Wall thickness must conform to acceptable engineering standards and comply with Federal, State, county and local zoning codes. Usually, no less than 3-inch

thick, reinforced walls should be constructed to prevent the exit of any projectiles.

NOTE: This specification usually requires the use of steel or similar material where wooden walls are used. The size depends on building design, geological conditions, and climate. Size includes the height, thickness, and length of the running wall.

(e) Ceiling. Ceiling material should reduce sound, protect lighting devices, reflect light and be impenetrable. Typically, ceilings include 10-gauge steel baffles, 2- by 4-feet white acoustic panels, and clear-light panels.

1 The ceiling should be a minimum of 8 feet above the floor level and have an acoustically treated, smooth surface to allow for positive air movement downrange.

2 Baffles to protect adjoining areas should be above a false ceiling or designed into the roof/ceiling structure.

(6) Shooting Booths. Commercial or locally built shooting booths may be desirable on pistol ranges; however, they are not recommended for rifle ranges. Shooting booth panels can provide an impenetrable barrier between shooters, reduce sound levels, restrict the travel of brass, and act as a spray shield when revolvers are used.

(a) Shooting booths should be omitted for ranges that use only rifles.

(b) A shooting booth should never extend more than 18 inches behind the firing line because greater extension may obstruct the range control officer's visibility.

(c) Bullets fired from any firearm used on the range must not be able to penetrate booth panels. The booth panel must be able to withstand the impact of a bullet fired at any angle to the surface and at point-blank range.

(d) Design criteria for the construction of booth panels are as follows:

1 Cover the 10-gauge steel plate with a nominal 2 inches of soft wood. In a series of tests using 10-gauge steel plate, firing all lead bullets at right angles, the plate covered with a nominal 2 inches of soft wood withstood direct hits from all standard pistol calibers up to, and including, .44 caliber magnum;

2 Use special acoustical materials to ensure that panels reduce muzzle blast effects on all shooters and range personnel;

3 Ensure that panels do not restrict airflow;

4 Ensure that panels do not restrict the range officer's visibility of the firing line; and

5 Construct panels so they extend from the floor to a minimum height of 6 feet. Panels should be ceiling height.

(7) Target Carriers and Turning Mechanisms. An indoor range can be operated more efficiently and safely by installing a target transport system. This system may be a simple, hand-made device or a completely automatic, electrically powered system. Either one will enhance safety by eliminating the need to walk downrange to replace targets. Target carrier systems speed up range operations. A turning target mechanism is available that faces the target parallel to the line of sight and then turns the target 90° to the line of sight to begin the stated time period. The target carriers should position the targets in the approximate center of the backstop.

(8) Control Booth. Range control booths must allow for maximum visibility and provide for easy access into and out of the range and ready area. The control booth should provide seclusion from and immediate access to the range environment. This design protects the range officer from frequent exposure to high sound levels and lead emissions.

(9) Communications. A communications system capable of relaying range commands distinct and separate from the sounds generated by shooting activities is required. Communications systems must account for shooters who wear two pairs of hearing protectors and persons who have substantial hearing loss.

(10) Ventilation and Filtering Systems. This section deals with the design or redesign of ventilation systems for indoor firing ranges. Administrative or engineering controls must be instituted to prevent shooters from being exposed to airborne lead levels exceeding acceptable limits. Administrative controls are used either when engineering controls fail to reduce exposure or when range use exceeds HVAC system specifications. Administrative controls are especially applicable to reducing risks on existing ranges.

(a) Administrative controls used to reduce exposure levels on an indoor range must be rigidly followed and enforced, and

compliance must be recorded in a log book for purposes of analysis and reference.

(b) The following administrative controls are provided and must be used where individuals are frequently exposed to airborne lead.

1 Provide range maintenance personnel with appropriate PPE, e.g., safety glasses and respirators.

2 Provide proper HEPA filter cleaning equipment. The equipment must be able to remove accumulated lead dust from floors, walls, and ledges and must include attachments capable of removing lead-laden sand from the backstop area.

(c) A ventilation system must be installed that will provide clean air in the user's breathing zone to reduce exposure to potentially dangerous materials to safe levels.

(d) Adopt administrative controls that monitor and control exposure time for a given user and/or assigned range personnel.

(11) Lighting.

(a) A visually safe facility should be free of excessive glare and major differences in light levels. Therefore, floors and ceilings should be designed to provide light reflection. In the event of a power outage, battery-powered emergency lighting must be provided for emergency exits.

(b) Rheostat-controlled lighting fixtures, which can reproduce near-daylight and low-light conditions, are best suited for indoor ranges. Range lighting involves three systems: general lighting, local lighting, and semi-direct lighting.

1 General lighting provides uniform light levels over the entire range area and adjoining areas and is usually installed in a symmetrical arrangement to blend with the architecture.

2 Local lighting supplements general lighting along the firing line to provide better visibility for those tasks associated with the loading and firing of firearms.

3 Semi-direct lighting distribution directs 60 to 90 percent of the lighting on the target with a small upward component to reflect from the ceiling and walls to soften shadows and generally improve range brightness. When ceilings are

white, lighting fixtures mounted too close together create excessive glare.

(c) Lamp specifications for general lighting must be adjustable to provide 0.2 to 50 foot-candles of luminance measured at a point 7 yards from the target line. Local lighting should produce 0.2 to 60 foot-candles of luminance on the firing line. Semi-direct lighting on the targets should achieve 0.2 to 100 foot-candles of luminance. Glare should be reduced or eliminated by incorporating pastel colors in the interior design.

(d) Lighting designs should also seek to balance the color of light emissions. For example, most fluorescent fixtures produce high levels of blue, which alone are not suitable for indoor ranges. If fluorescent fixtures are used, green tubes or other light sources should be installed to balance the colors.

(12) Plumbing. Plumbing requirements specify that there must be a fresh water supply for personal hygiene and for range cleaning chores. There also must be a waste removal system for normal waste material and material removed from the range. An approved filtration system must be provided for range cleaning waste. Floor drains should be connected to this alternate waste system. Restrooms, showers, and sinks should be connected to a regular sewer system.

(13) Sound Control. Sound control on indoor ranges includes two distinct components: airborne and structure-borne sound. For airborne sound, all leaks into outer areas should be sealed, which includes airtight insulation around doors, windows, HVAC ducts, walls, and ceilings. Structure-borne sound reduction is necessary to protect adjoining, occupied rooms. Acoustical material should be applied to walls, HVAC ducts, floor, and ceiling areas.

(14) Range Control. Range control provides rules and supervision that encourage safe and proper use of a range. Safety devices control the physical use of an indoor range and may include warning lights, alarm bells, switch locations, etc. For example, an indoor range with a door in the downrange area should be equipped with an alarm. The door could also be secured by a mortise lock or barred from within but must remain a fire exit. Fire codes generally prohibit bars on doors that would delay escape from a building. Emergency personnel must be able to access the doors. Any door that can be accessed from the outside must be marked with warning devices to indicate when the range is in use. When installing doors on indoor ranges, refer to Life Safety Code National Fire Protection Association (NFPA) 101.

(15) Target Carriers. Target carriers are used for the convenience of shooters to allow them to continue shooting without delay when target changes are necessary. For health considerations, target carriers keep shooters out of the high lead concentration areas and safely behind the firing line.

(16) Heaters. Protected heating units should be installed behind and above the firing position to provide a comfort zone for shooters.

(17) Gun Racks. Gun racks should be mounted behind the firing positions as an additional safety feature to reduce gun handling and to keep the range areas orderly. Appropriate material should be used to construct the gun racks, and the design must correspond to the weapons being used.

6. LIVE FIRE SHOOT HOUSE.

a. Introduction.

(1) A live fire shoot house (LFSH) is intended for use in advanced tactical training for Security Police Officers. Use of this facility includes individual tactics or Special Response Team force option training. All LFSHs must have an elevated observation control platform (EOCP). The following sections illustrate recognized construction methods for LFSHs. However, they do not eliminate the requirement for sound professional engineering design and validation.

(2) Administrative controls not directly related to design and construction must be in place during facility use. The administrative controls and engineering design allow for a reduction in physical barriers that prevent rounds from escaping the facility. Designed barriers must prevent a round fired with a vertical upward error of 15° from escaping the facility.

b. Site Selection.

(1) Site selection for an LFSH is similar to that for any range facility. Terrain features, noise, and availability of utilities and access roads must be considered, as already discussed in previous sections for indoor and outdoor ranges. The LFSH should be placed adjacent to other range facilities whenever possible so that it may utilize the same support facilities, access roads, etc.

(2) Facility design, target and shooter placement, and other administrative controls minimize the possibility of rounds being fired over the top of the walls and leaving the structure and mitigate the need for an SDZ outside the confines of the LFSH proper.

c. Design and Layout.

(1) The interior layout of the facility is based on the mission and training requirements of the site. Facility design should incorporate a wide variety of room configurations. Some of the room configurations that should be considered are: multiple floors, an L-shaped room, stairwells, rooms within a room, hallways, and closets.

(2) The floor plan design should accommodate the movement of target systems, bullet traps, and other equipment into and out of the LFSH.

(3) Exposure to airborne contaminants for a fully enclosed LFSH must be controlled by adequate ventilation. The lighting requirements are similar to those for indoor ranges.

d. Wall Construction.

(1) Wall Height. Exterior walls of the LFSH must be designed to absorb the most energetic projectile identified for use within the facility. Wall height must be a minimum of 8 feet. The wall height should allow a maximum error angle of 15° from horizontal standing shooting distance from the target and still enable a projectile to be contained by the wall, which can be described by the following equation: Wall Height is equal to the muzzle height plus 0.27 (tangent 15°) times the target distance. The following table assumes a muzzle height of 5 feet.

Distance from Muzzle to Ballistic Wall (Feet)	Wall Height (Feet)
11' 1"	8' 0"
13' 3"	8' 6"
14' 10"	9' 0"
17' 0"	9' 6"
18' 6"	10' 0"
20' 9"	10' 6"
22' 2"	11' 0"
24' 5"	11' 6"
25' 11"	12' 0"

If the distance from muzzle to ballistic wall exceeds the required wall height, other administrative, engineering or natural ballistic wall controls must be administered or considered such as shooter-to-instructor ratio, canopies, baffles, natural terrain, existing SDZ, standard operating procedures, and training.

(2) Ballistic Walls. Ballistic interior walls are the preferred method of construction. Where non-ballistic interior walls are used, additional administrative controls must be applied to target placement and team

choreography. Ballistic walls are required in all cases where containment of the round and protection of personnel is paramount.

(a) Footings. Footings must be designed using the engineering criteria that best ensures structural integrity and stability of wall construction.

(b) Composite Walls.

1 A combination of ¾-inch exterior grade plywood and steel is effective. Minimum thickness will be ¼-inch mild steel with an exterior-grade plywood separated by a minimum of ¾ inch with a maximum of 1½ inches from the steel surface.

2 Other combinations are possible. The main criterion is that the wall must stop any round fired and contain bullet fragments.

(3) Non-Ballistic Walls. These walls are constructed of materials that offer no protection to personnel or equipment in adjoining rooms. Material used for these walls must not contribute to or enhance ricochet or splatter. Additional administrative controls must be applied such as target placement and team choreography.

e. Doors. All doors must be constructed of wood with no glass. Additionally, at least a portion of the rooms must have working doors, some opening inward, some opening outward, and doors opening left and right.

NOTE: All devices in the LFSH, such as brackets and hangers, used to secure walls to floors or secure doors must be covered or protected to mitigate any tripping or ricochet hazards.

f. Ceiling or Roofs. Ceilings or roofs can be of value when the shoot house is required for year-round use in areas with severe weather conditions. Exposure to airborne contaminants must be controlled by adequate ventilation. The lighting requirements for fully enclosed shoot houses are similar to those for indoor ranges. When training exercises require target placement above the wall design, the ceiling or roof must be protected unless firing into an approved SDZ.

g. Floors.

(1) Floor construction must be selected for its ability to absorb direct fire, minimize ricochets, and provide a walking surface free of slipping/tripping hazards. Floors should provide the same ricochet protection as walls. Options include:

(a) exterior-grade plywood floor constructed in accordance with American Plywood Association guidelines over smooth finished concrete;

(b) concrete with brushed surface that minimizes slip and tripping hazards;

(c) asphalt;

(d) exterior-grade plywood;

(e) shredded bias-ply tires; and

(f) earth, free of rocks and debris that could cause ricochet.

(2) Construction joints between walls and floors must be designed to contain projectiles within the LFSH.

h. Bullet Traps.

(1) General Information.

(a) Targets used in LFSHs must be placed so that fire is directed into a bullet trap designed to capture the rounds.

(b) Bullet traps must be constructed to contain the most energetic projectile to be fired into them without dimpling/pitting the steel and contain splatter and fragments in all directions. The size and shape of a bullet trap may be altered, but materials may not be substituted.

(2) Specifications for construction.

(a) 5.56mm conventional ammunition must not be used when shooting into bullet traps without further testing and development of containment materials. Only 5.56mm non-toxic frangible ammunition can be used.

(b) Bullet trap steel must be set at a minimum 7° angle off vertical based on the most probable line of flight of the bullet. The greater the angle of the bullet trap, the less the deterioration on the steel plate. A bullet trap constructed similar to the DOE National Training Center design (see Figure 20) and then leaned against the wall of the shoot house with the base of the trap out approximately 1 foot provides adequate angle of the steel backing.

(c) Bullet trap steel must be constructed of a minimum ¼-inch, 500 Brinell hardness or equivalent rifle-grade steel. Quality

assessment and ballistic test sheets certifying the grade and quality of the steel backing plate must accompany every steel backing plate utilized.

(d) An anti-splatter shield must be used in front of the steel to prevent back splash. Two layers of 7/16-inch nylon-impregnated rubber belting material or ¼-inch self-sealing co-polymer sheeting are good examples of material to use.

(e) An air space must be left between the face of the steel and the facing material to allow fragments to collect in the rear of the trap. A 1¾ -inch air space is an accepted construction standard.

(f) Linatex™ rubber backing material between the fascia and steel backing plate is not recommended because it deteriorates rapidly when using 5.56mm frangible ammunition.

(g) Plywood under the fascia material and in front of the steel plate is not recommended because the material deteriorates rapidly with 5.56mm frangible ammunition.

(h) Bullet traps must be constructed for easy inspection of the inside of the fascia material and the front of the steel plate. Frequent inspection of the interior of the bullet traps must be conducted when rounds are fired into one general area.

(i) The fascia material must be inspected, replaced or repaired when the integrity of the fascia material allows the round to start dimpling the steel backing plate.

(j) The bullet trap steel backing plate, when used in the standard bullet trap design, must be replaced when 50 percent of the material in one general area has been chipped away.

(k) The requirement to remove from service any steel target when dimples exceed 1/16 inch does not apply. Steel backing plates must have a protective cover installed between the plate and the shooter that protects the shooter from back splash.

i. Elevated Observation Control Platform.

(1) EOCPs enhance the ability to observe and control LFSH operations. Administrative controls must be considered when constructing the EOCP. Platform construction and location is based on the training to be conducted. EOCPs must be constructed in accordance with all applicable regulations for elevated work platforms.

(2) EOCPs must be constructed to:

(a) maximize instructors' observation and control of the entry team fire and movement;

(b) facilitate communication between instructors on the EOCP and the floor;

(c) position the lowest point of the horizontal walking surface higher than the 15° vertical error for any target engaged;

(d) provide ready access;

(e) integrate instructors' movement with team flow;

(f) maximize instructors' ability to see shooters clearly at all times; and

(g) have supporting structures placed so that they pose no additional hazards such as tripping, ricochet, splatter, etc.

ATTACHMENT 1 -- RANGE DESIGN FIGURES

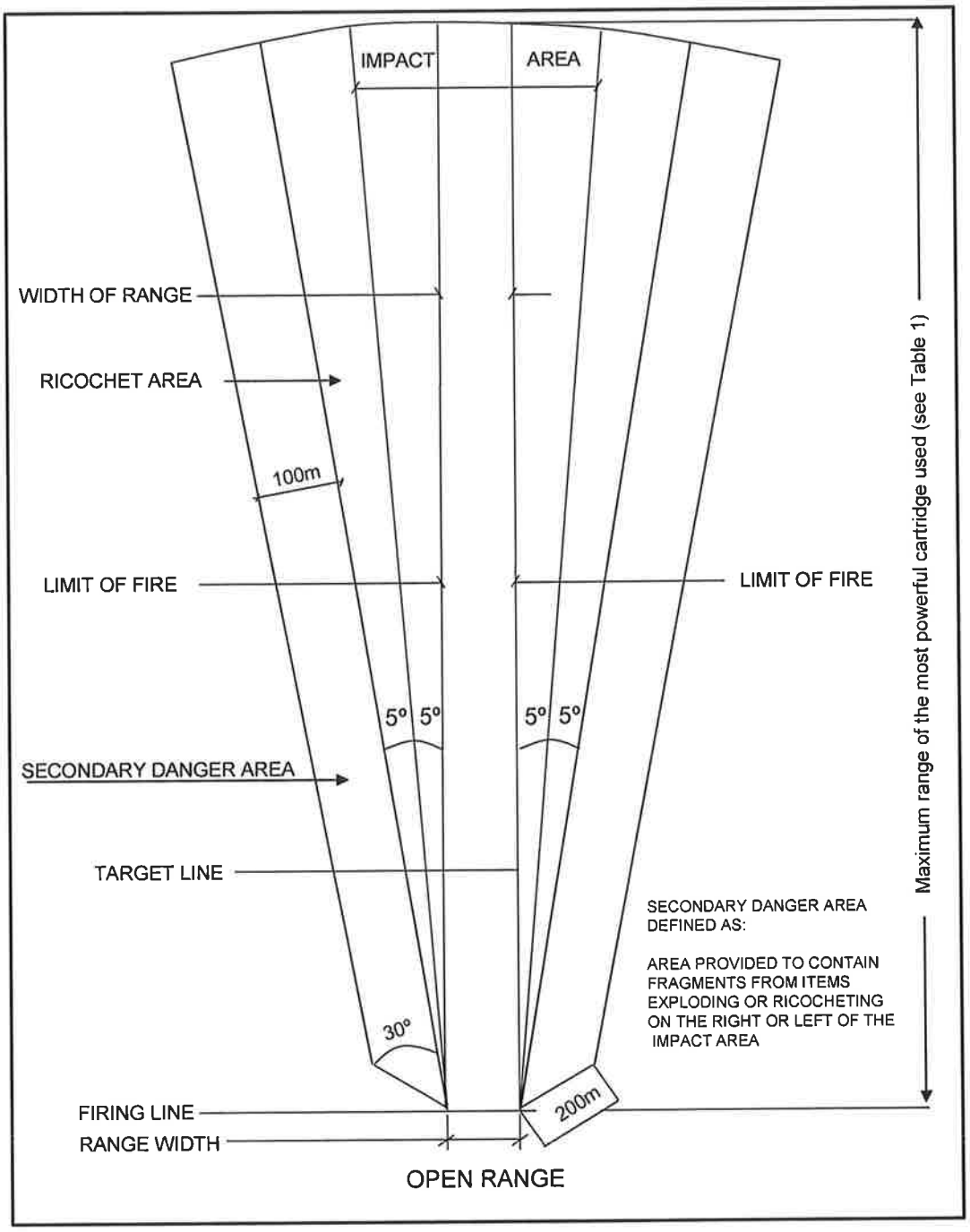


Figure 1
Surface Danger Zone for Small Arms
Firing at Fixed Ground Targets

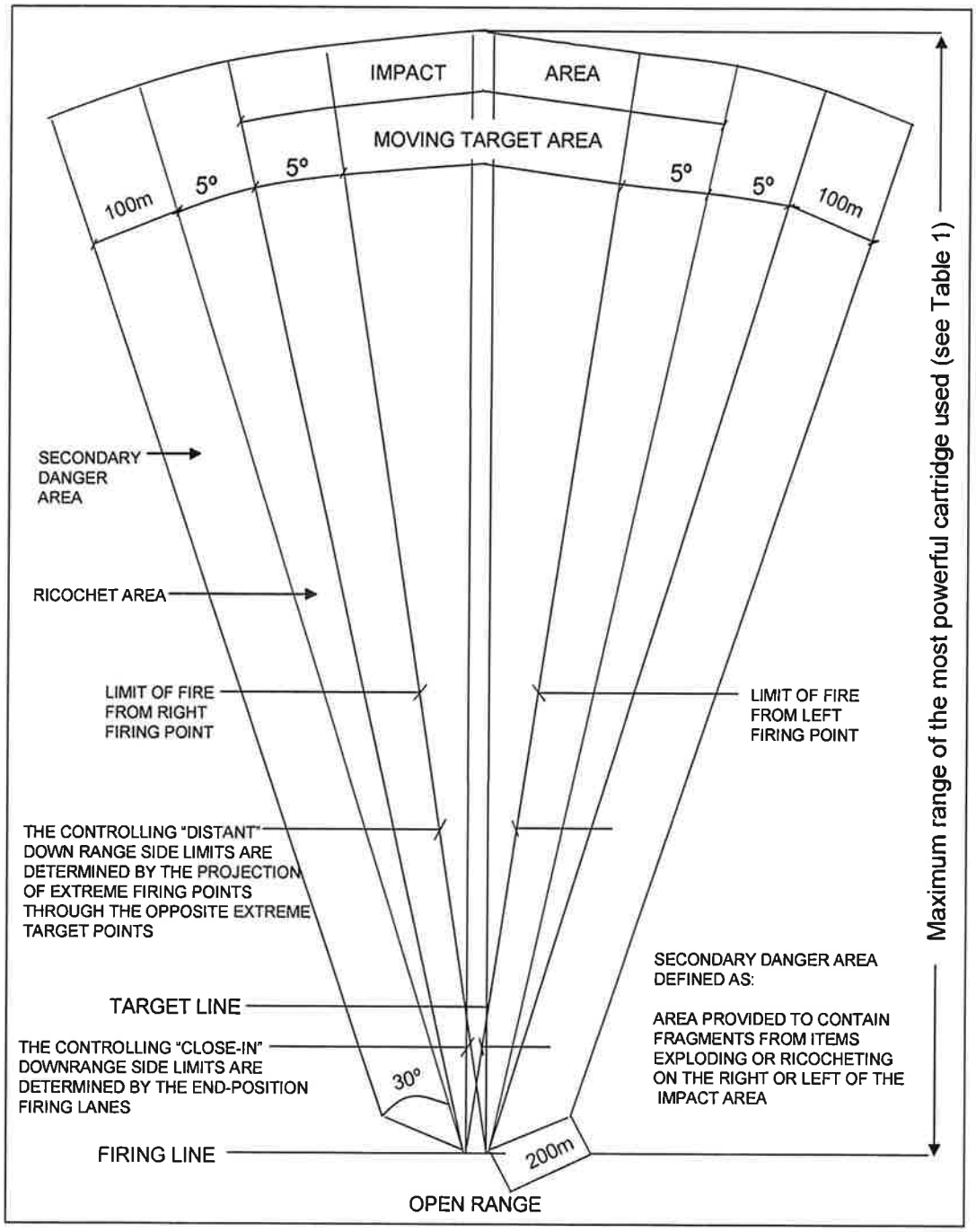


Figure 2
Surface Danger Zone for Small Arms Weapons
Firing at Moving Ground Targets

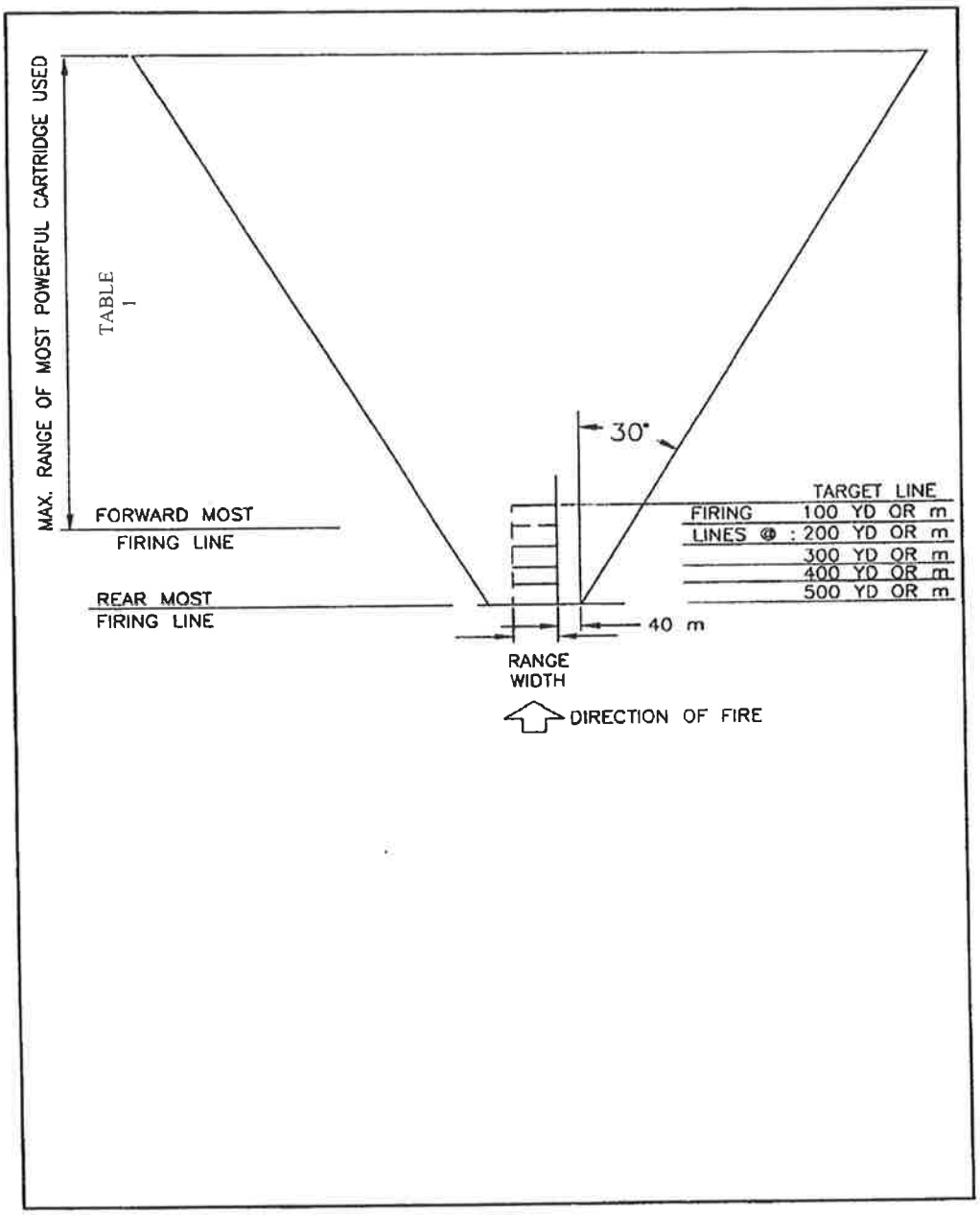


Figure 3
Surface Danger Zone for Small Arms Firing
At Fixed Ground Targets with Rocky Soil
Or Targets Causing Ricochet

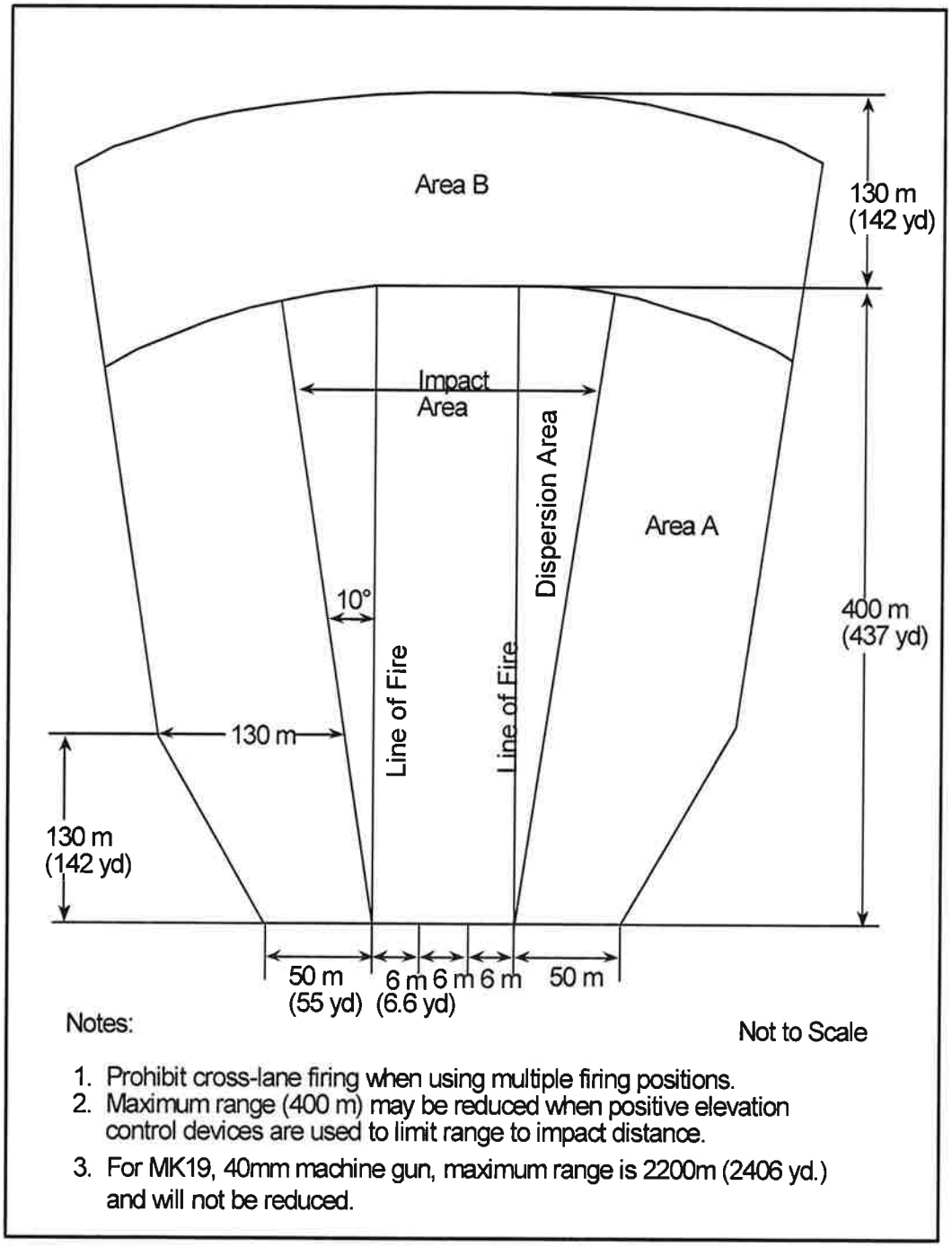


Figure 4
Surface Danger Zone for Firing
M79, M203, and M19 40mm Grenade Launchers

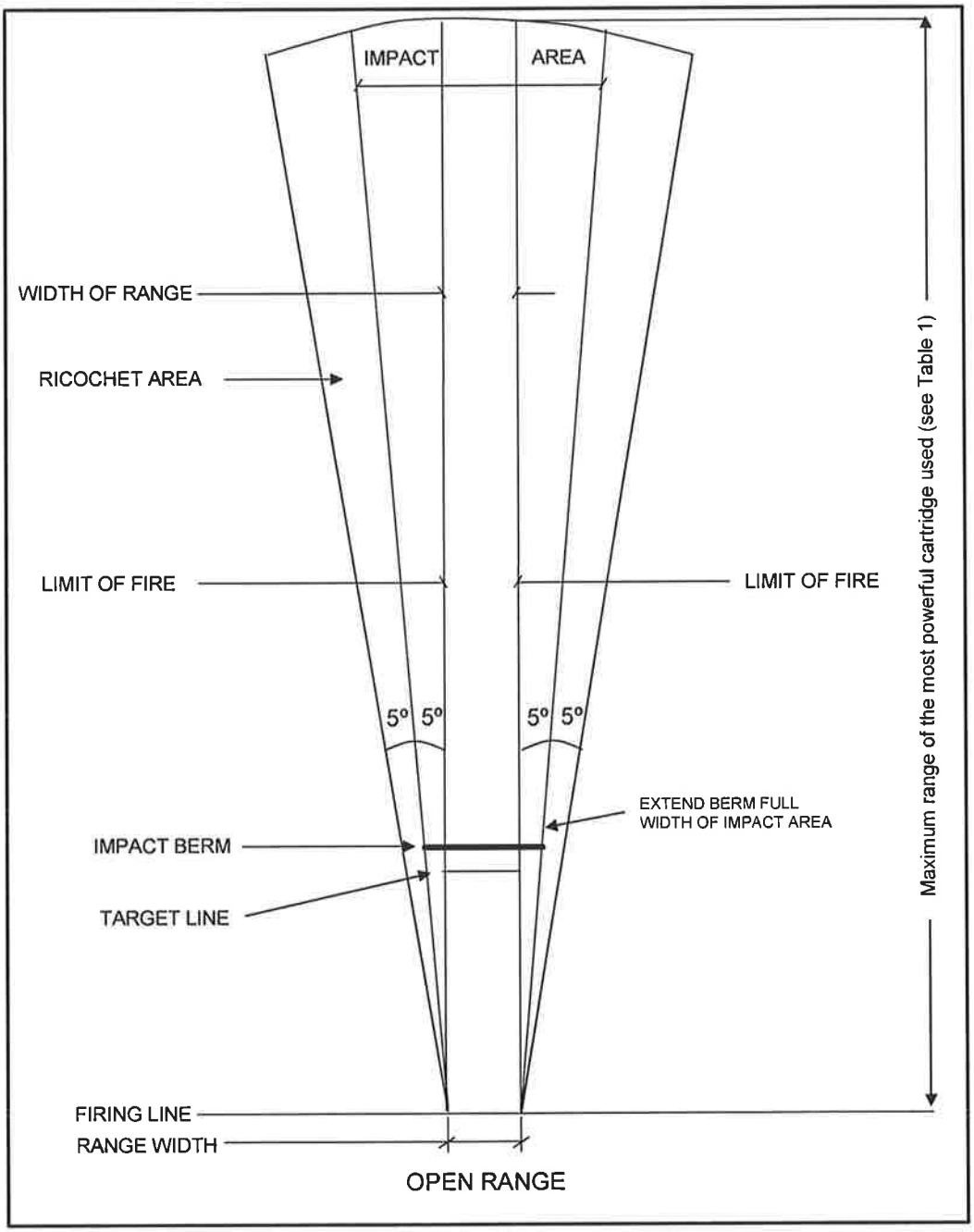


Figure 5
Surface Danger Zone with Impact Berm
for Small Arms Firing at Fixed Ground Targets

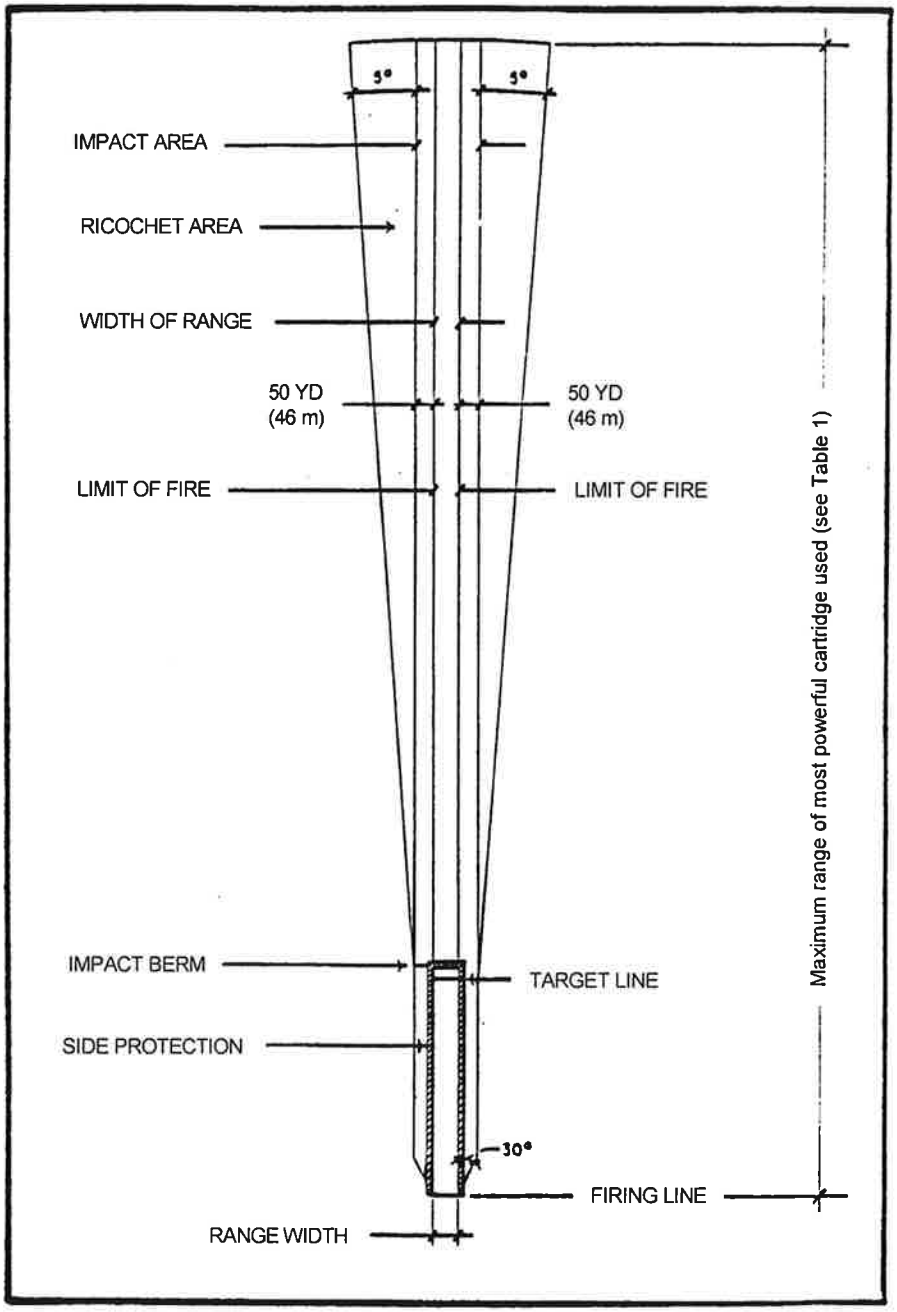


Figure 6

Open Range with Impact Berm and Side Protection Surface Danger Zone for Small Arms Firing at Fixed Ground Targets

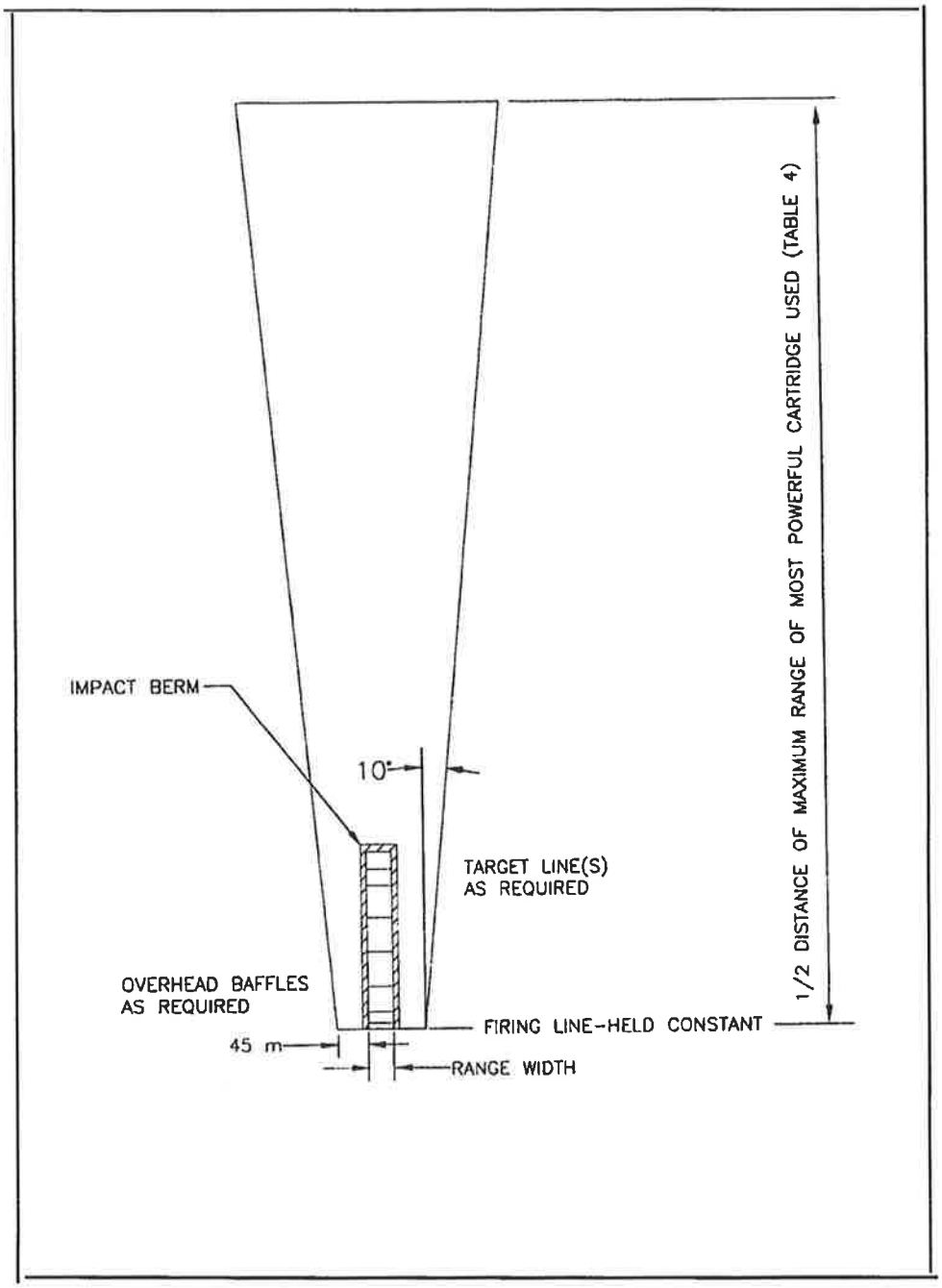


Figure 7
Surface Danger Zone for Partially Baffled Range
(Small Arms Firing at Fixed Ground Targets)

(TABLE 1)

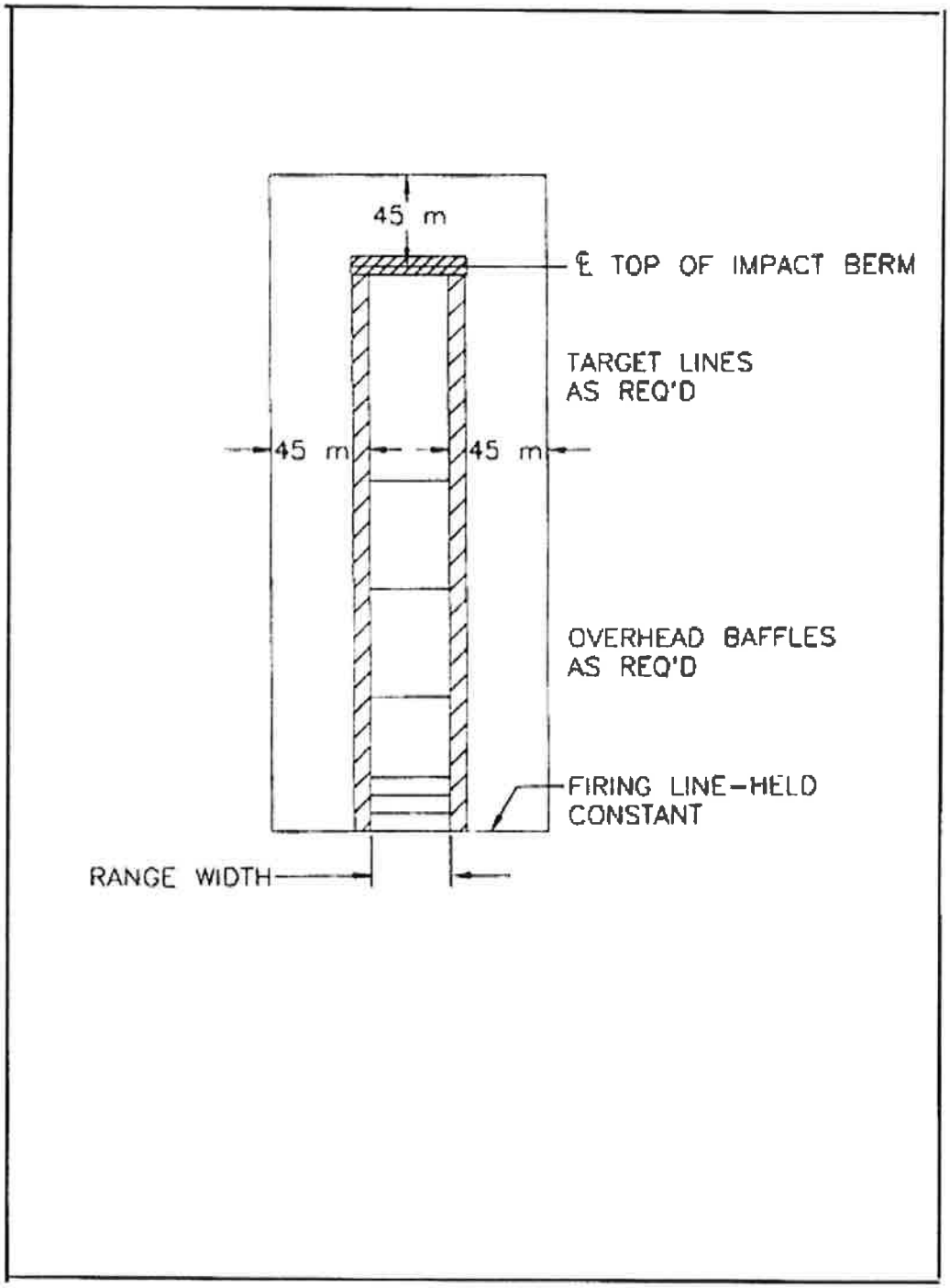


Figure 8
Surface Danger Zone for Fully Baffled Range
(Small Arms Firing at Fixed Ground Targets)

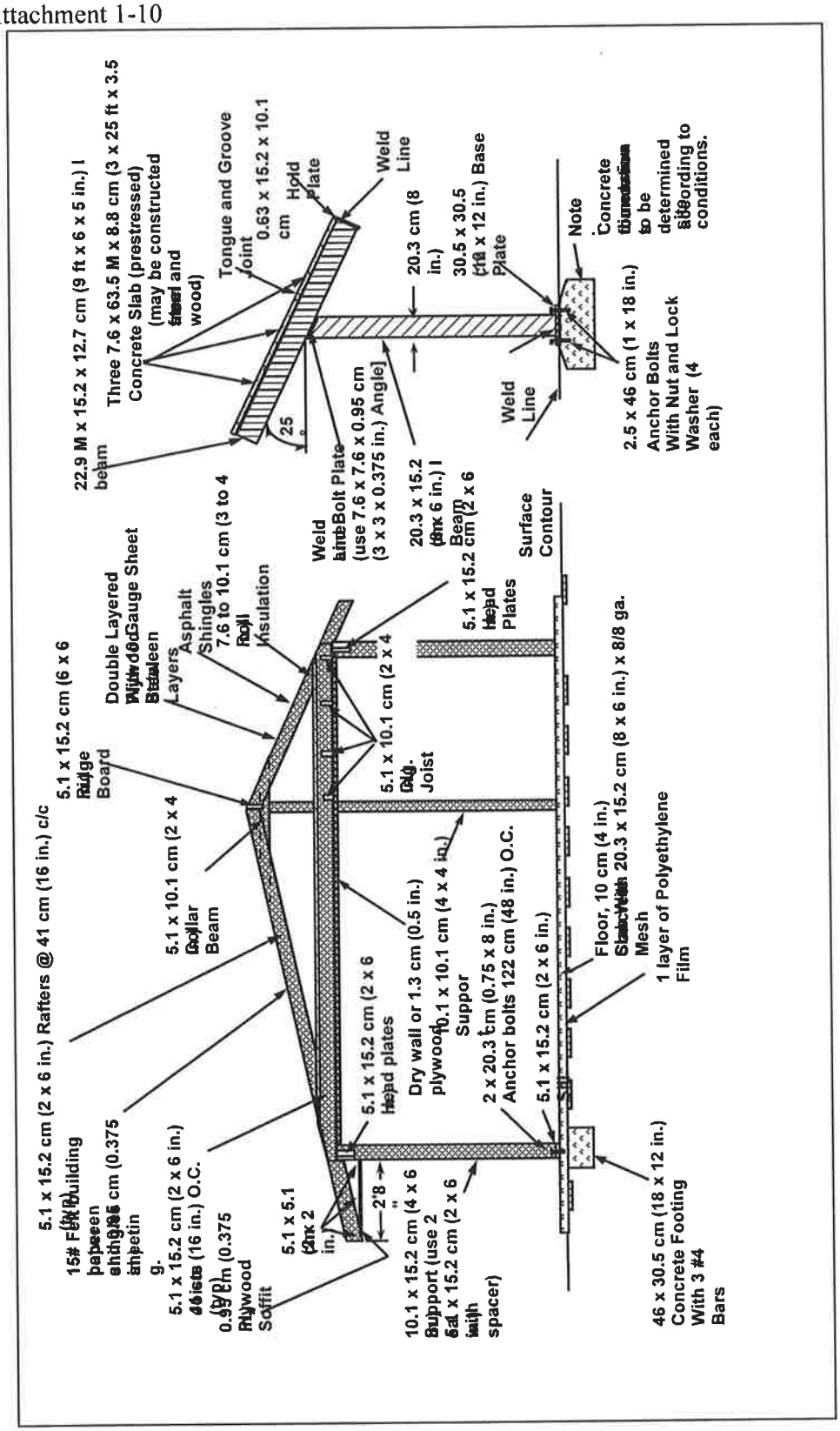


Figure 9
Ballistic Overhead Canopy

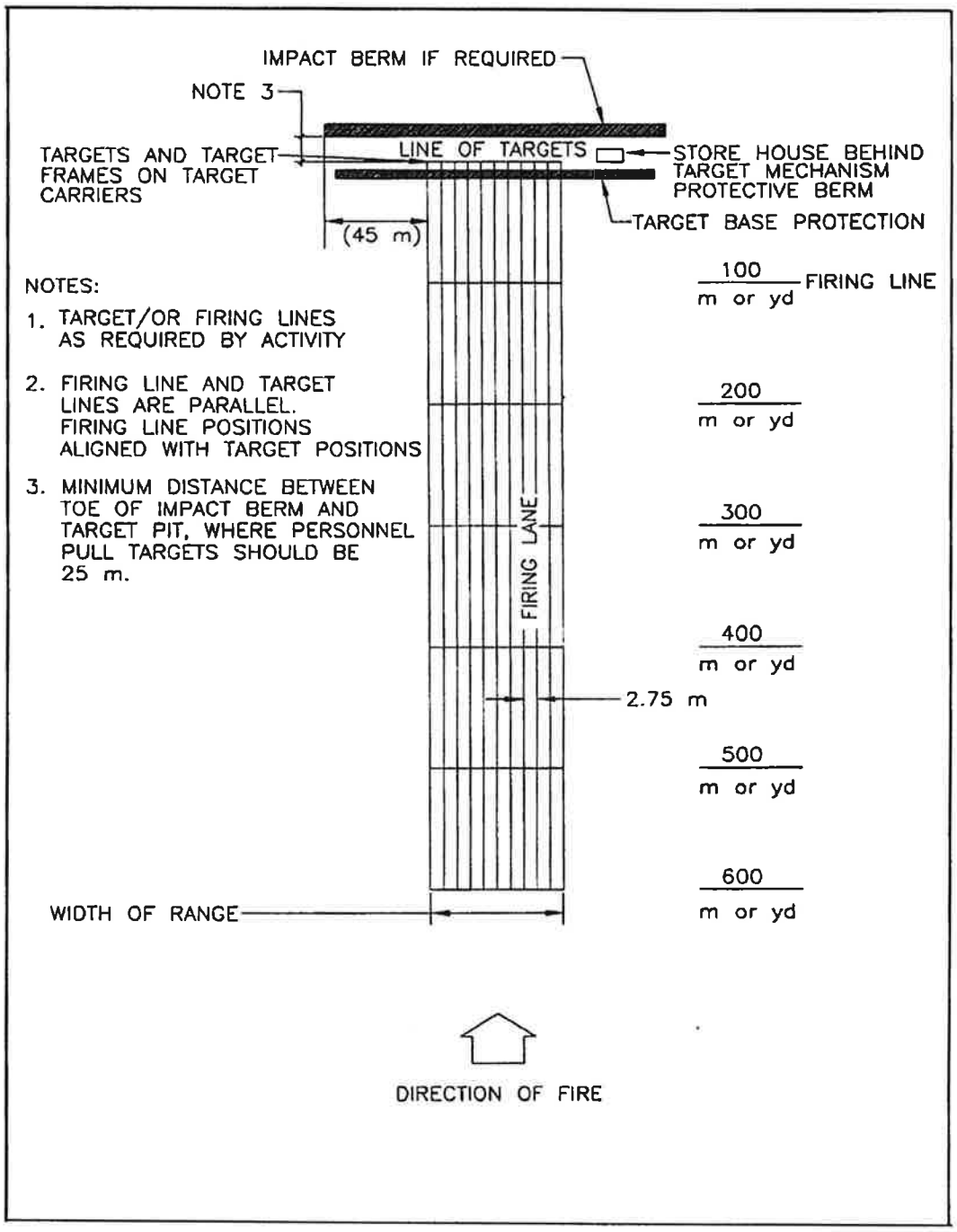


Figure 10
Outdoor Rifle Range Layout

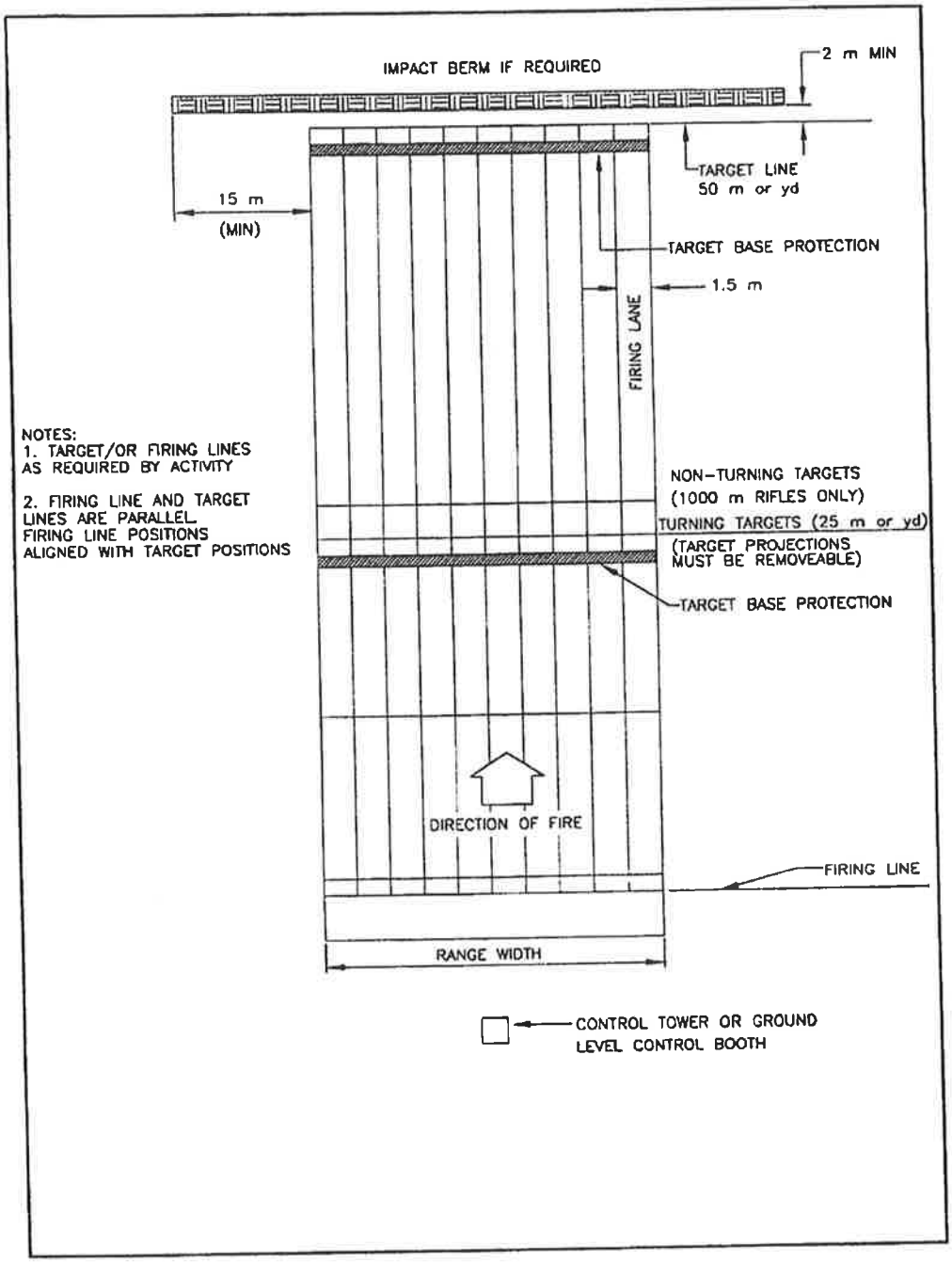


Figure 11
Pistol Range Layout

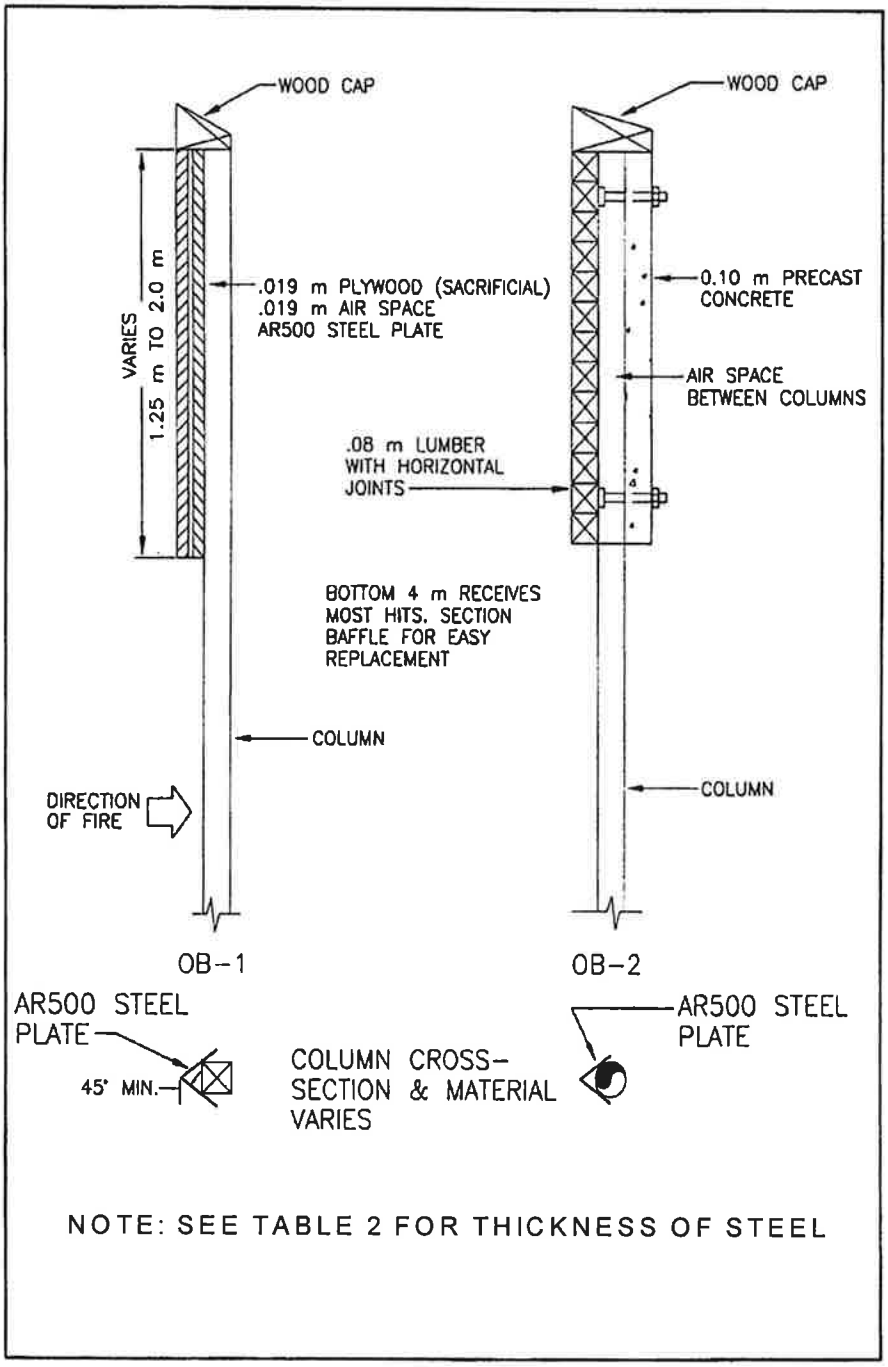


Figure 12
Ballistic Material

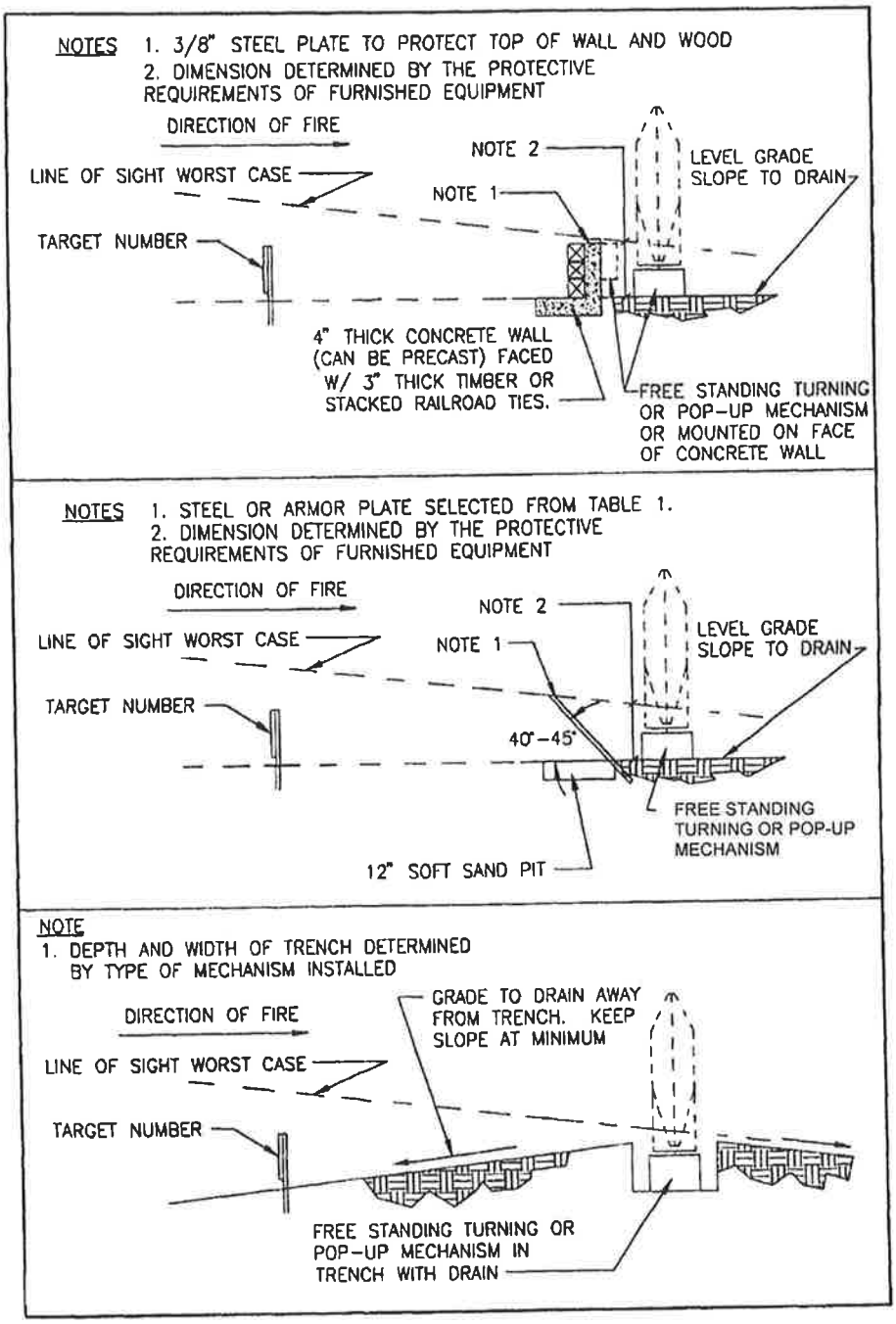
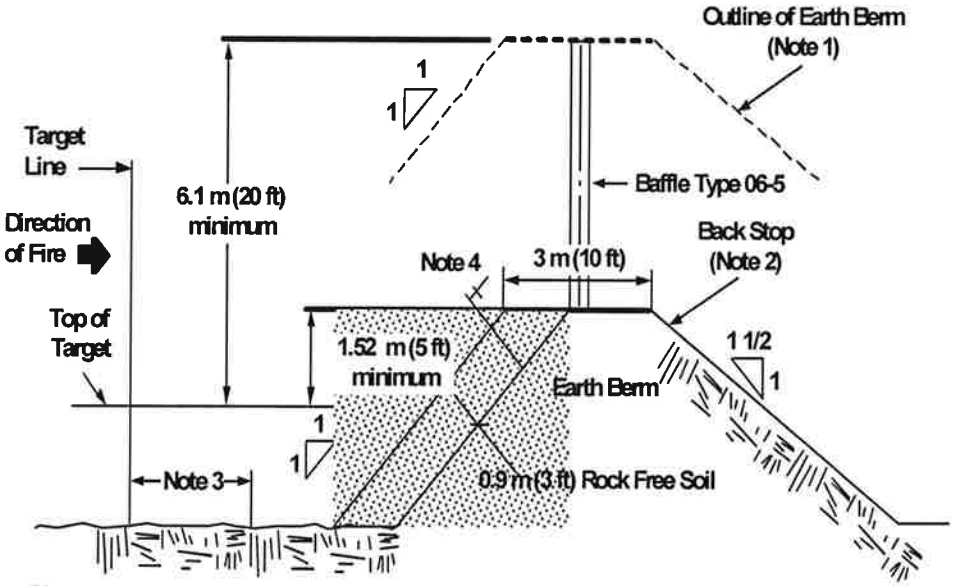


Figure 13
Ballistic Protection of Target Mechanism



Notes:

1. Outline of impact berm if all earth berm is used in lieu of combination earth berm/baffle.

2. Back slope may be increased or decreased dependent upon soil stability, erosion potential, or maintenance equipment.

3. Provide adequate distance between berm and target line for maintenance of target and slope of berm [minimum 9 m (10 yd)].

4. Preferred slope of impact berm face is 1:1 or steeper. For shallower slopes a bullet catcher is required. Top baffle must be placed as shown if used in lieu of all earth berm. Bullet catcher is 0.95 cm (3/8 in.) steel plate positioned above point of bullet impact at 90° angle to face of berm slope. Plate protrudes at least 0.6 m (2 ft) from face of berm.

Figure 14
Impact Berm for Open and
Partially Baffled Ranges

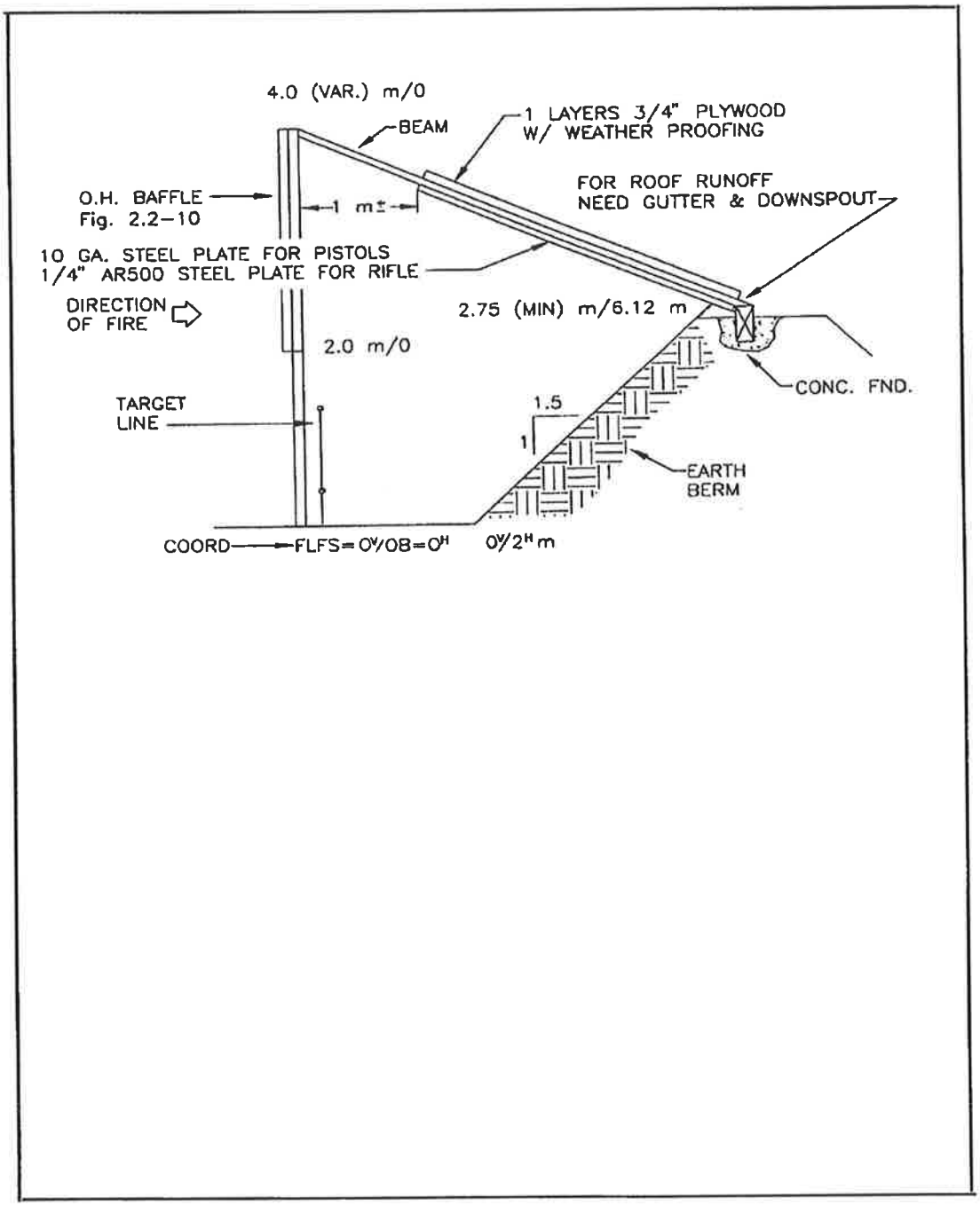


Figure 15
Outdoor Bullet Trap

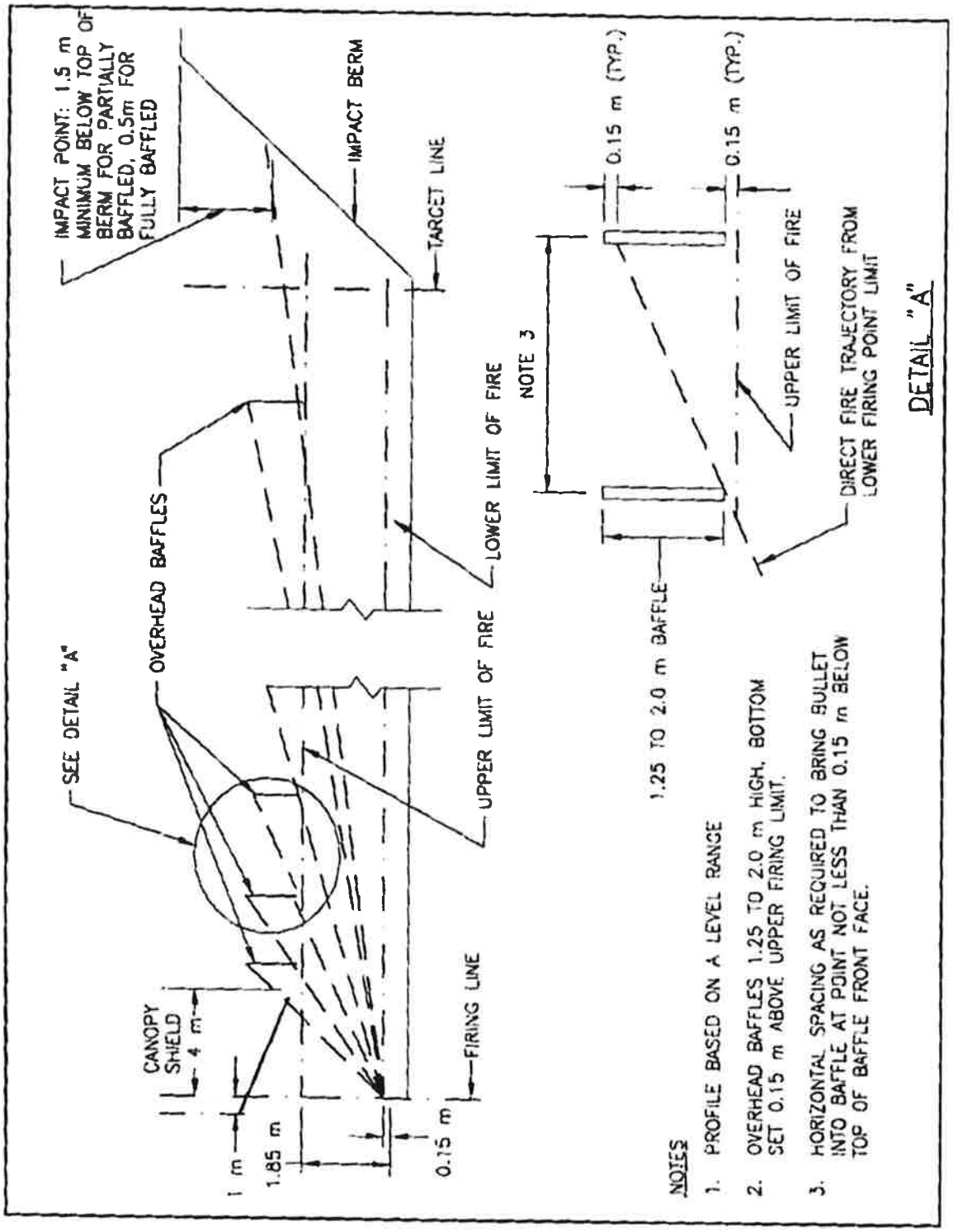


Figure 16
Baffled Range Profile

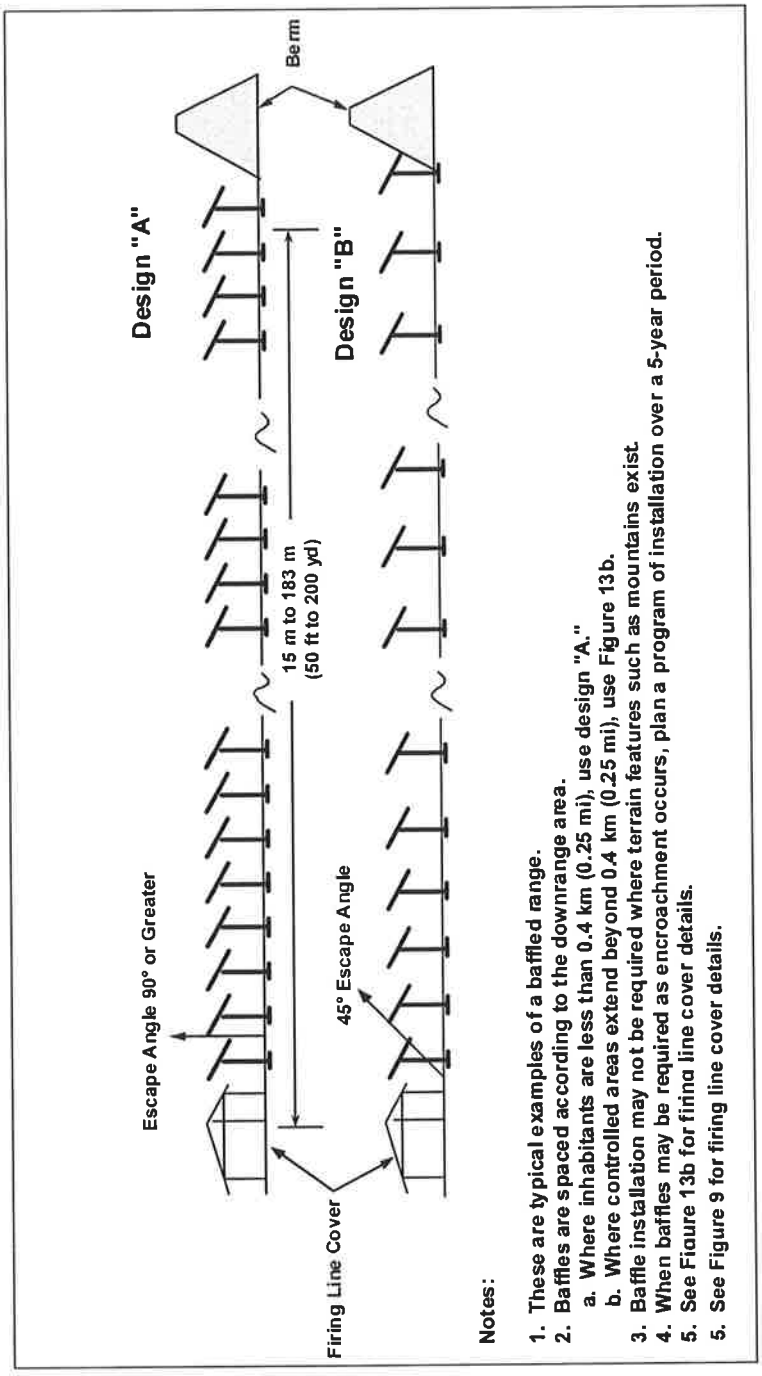


Figure 17
Baffle System Geometry

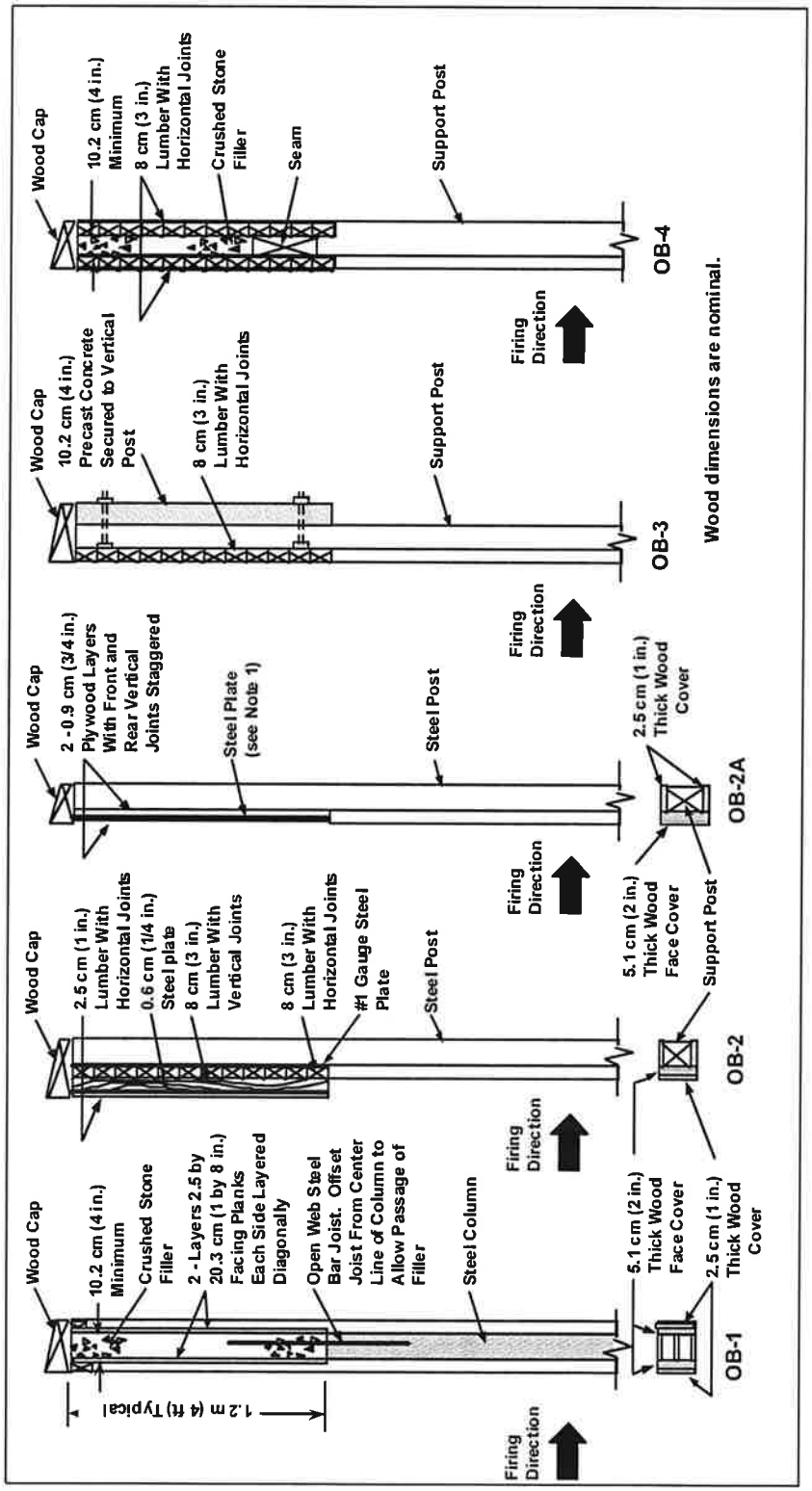


Figure 18
Overhead Baffle Ballistic Designs

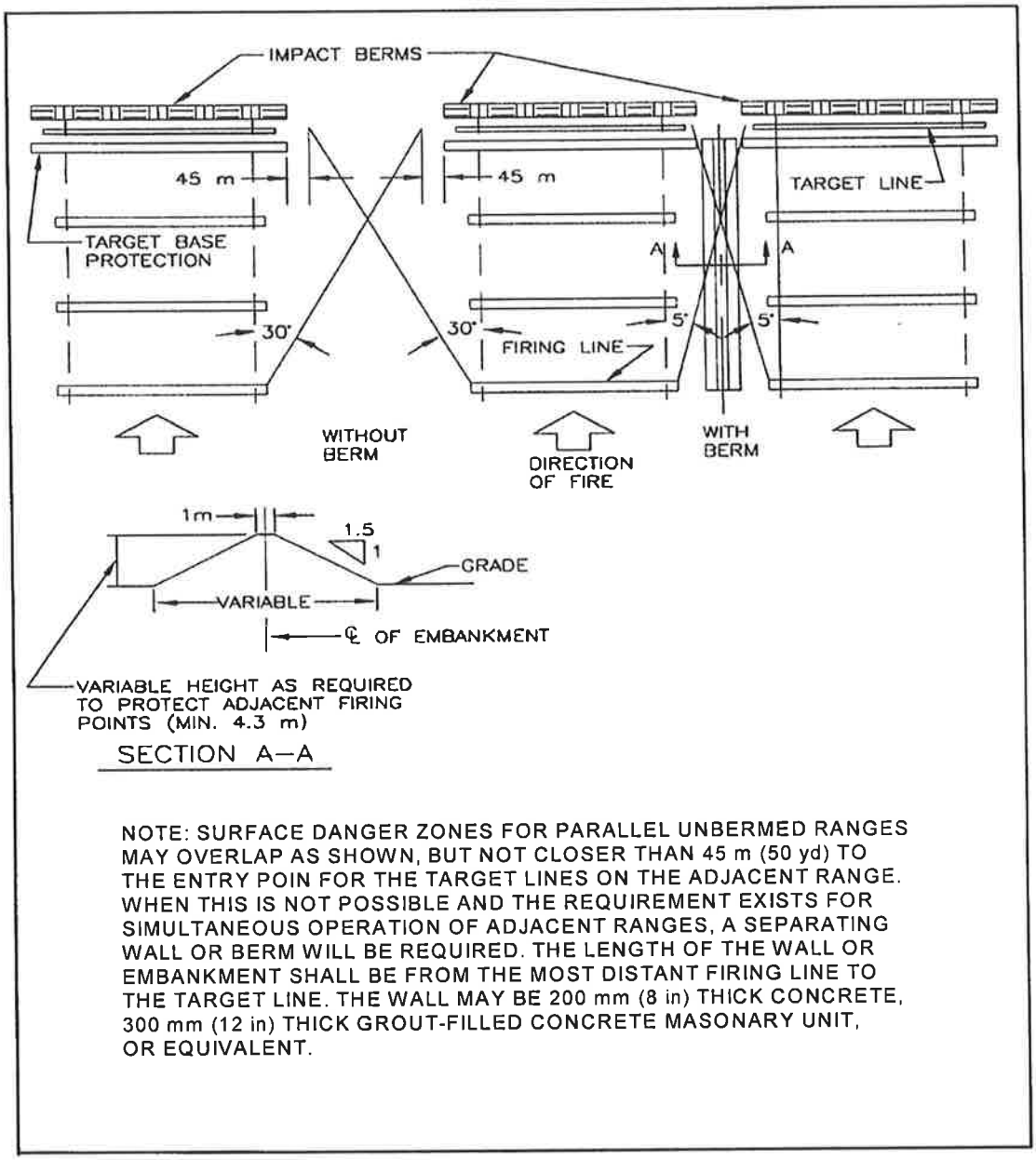
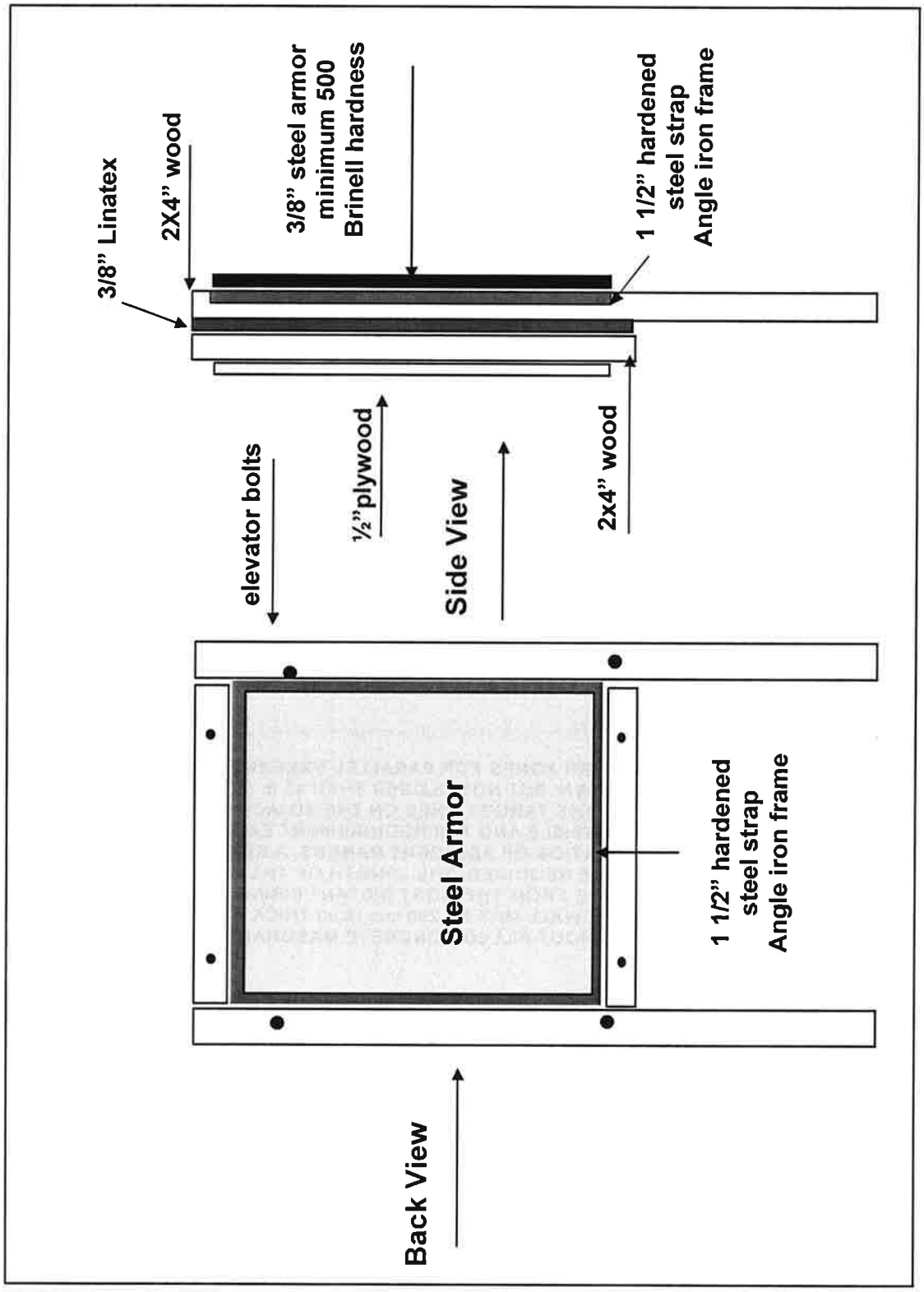


Figure 19
Parallel Ranges


3/8" Linatex
2X4" wood
3/8" steel armor
minimum 500
Brinell hardness
1 1/2" hardened
steel strap
Angle iron frame
elevator bolts
½"plywood
Side View
2x4" wood
Steel Armor
1 1/2" hardened
steel strap
Angle iron frame
Back View

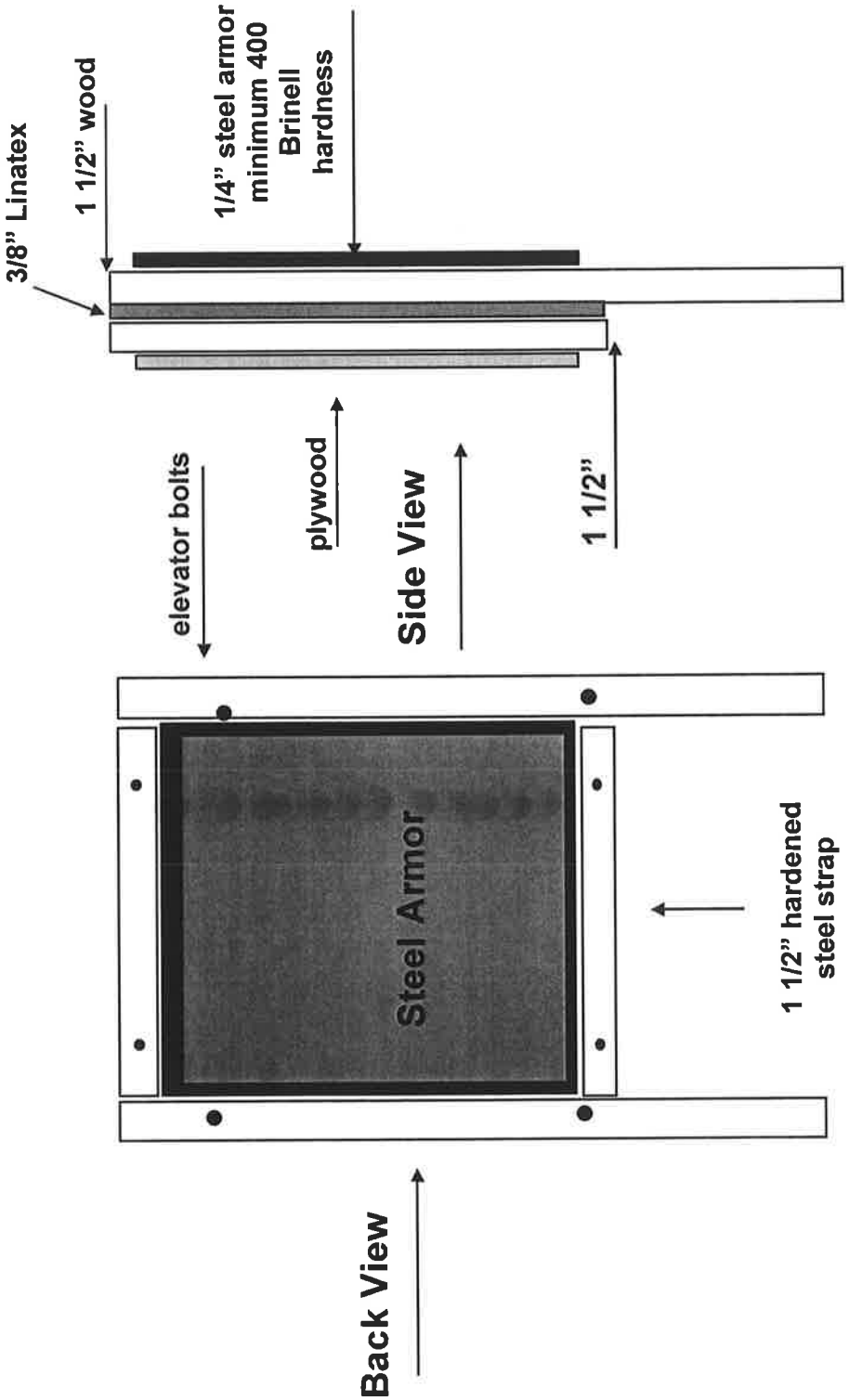


Figure 20
NTC BULLET TRAP

Appendix B

UNITED STATES MARINE CORPS

RANGE SAFETY POCKET GUIDE

USMC Range Safety Pocket Guide

Version 1.0

This portable guide provides references to MCO 3570.1B and DA PAM 385-63. It is not intended for use as a sole source of information for the MCO 3570.1B and/or DA PAM 385-63. For further information, consult the full versions of MCO 3570.1B and DA PAM 385-63.

Surface Danger Zone templates included in this guide are shown at a scale of 1:25,000 and 1:50,000 and are for reference only.

Range & Training Area Management Division
Training and Education Command
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Send questions and comments to:
TECOMRTAMSupport@tecom.usmc.mil

http://rtam.tecom.usmc.mil

Table of Contents

Summary

This pocket guide provides revised range safety policy for the U.S. Marine Corps. It establishes:

Surface danger zones as minimum safety standards

Range safety responsibilities for the unit commander, Officer in Charge (OIC), and Range Safety Officer (RSO) for all ranges, especially for live-fire operations;

Procedures for ammunition and explosives: positioning and issuing; suspension of ammunition and explosives involved in malfunctions; UXO and misfire procedures and reporting; and disposition of ammunition and explosives involved in malfunctions and accidents;

Risk-management principles and deviation authorities, and employs the operational risk-management process to identify and control range hazards.

For guidance beyond this pocket guide, refer to MCO 3570.1B and Department of the Army Pamphlet (DA PAM) 385-63

Purpose of this Pocket Guide

The purpose of this pocket guide is to provide the user with a quick ready reference for the field, in order to assist in developing a training plan. It provides standards and procedures for the safe firing of ammunition, demolitions, lasers, guided missiles, and rockets for training. When standards conflict with those of other military services, Federal agencies, or host nations, the standards providing the higher degree of protection apply.

Excerpts from Army Regulation 385-63, MCO 3570.1B, 19 May 2003

Applicability

a. The regulation/order applies to:

(1) Marine Corps commands, active and reserve. Local standing operating procedures and range policies will reinforce this order.

(2) Any person or organization utilizing an Army or Marine Corps controlled real estate or range.

(3) Range training and target practice activities

(4) All areas designated for live-fire weapons firing, including laser ranges, recreational ranges, and rod and gun club ranges located on Army or Marine Corps property controlled by the Army or Marine Corps

b. The regulation/order also applies to personnel training outside the United States. Army or Marine Corps commanders will apply the provisions of this regulation/order and host nation agreements as appropriate.

General

a. The commander is responsible for the safe conduct of soldiers/Marines involved in training operations.

b. All military commands and all Federal, state, local, and/or private organizations using Army and USMC ranges will adhere to the provisions MCO 3570.1B, DA PAM 385-63, and required publications.

Surface danger zones (SDZs)

a. Surface danger zones shall be prepared and updated as appropriate according to DA PAM 385-63 for all munitions and laser systems. Munitions and hazardous laser systems (such as class 3b and 4 lasers) will not be fired or employed on training ranges except within the confines of approved SDZs. Deviations from this policy shall

be in accordance with the provisions of Chapter 3, MCO 3570.1B and DA PAM 385-63. For Marine Corps air-to-ground ranges, OPNAV Instruction 3550.1 will be considered.

b. SDZs published in DA PAM 385-63 represent Army and USMC minimum safety requirements. They are adequate only when employed with properly functioning safety equipment and devices, and when trained and competent personnel follow published firing procedures.

c. If a round exits an approved SDZ, firing of that munition and weapon will cease locally until the cause of the round-out-of-impact (ROI) has been determined.

d. SDZs will be updated on the basis of data derived from research and development, testing, and/or actual firing experience. SDZs for new ammunition and weapons and modifications of existing SDZs will be approved and disseminated using the same procedures described in MCO 3570.1B and DA PAM 385-63.

Deviation limitations

a. Deviations are limited to:

(1) Reducing SDZ dimensions when terrain, artificial barriers, or other compensating factors make smaller SDZs safe.

(2) Modifying prescribed firing procedures to increase training realism (such as accepting increased risk when these risks have been incorporated into an approved SDZ) as appropriate for the proficiency of participating soldiers and Marines.

(3) Allowing personnel who are not directly participating in the actual conduct of training within the SDZ.

b. Deviations shall not be applied to other Federal agency directives/regulations such as airspace or water traffic requirements.

c. For live-fire training operations conducted under an approved deviation by nonresident units, the host installation commander must approve training at a host Installation.

d. Deviations may be authorized by the following personnel:

(1) MACOM commanders

(2) COMMFORLANT, COMMARFORPAC, COMMARFORRES, and commanding generals of all supporting establishment commands

(3) The Superintendent of the U.S. Military Academy

(4) Director, Army National Guard

e. Delegation of deviation authority

(1) MACOM commanders, COMMARFORLANT, COMMARFORPAC, and COMMARFORRES may sub-delegate, in writing, deviation authority to general officers in command positions, but not lower than installation commanding generals. This authority shall not be further sub delegated.

Excerpts from Department of the Army Pamphlet (DA PAM) 385-63, 10 April 2003

Range Safety Responsibilities

The unit commander:

a. Ensures compliance with MCO 3570.1B and DA PAM 385.63, applicable technical manuals (TMs), field manuals (FMs), and Fleet Marine Force Manuals (FMFMs) (Marine Corps), installation range guidance, and applicable SOPs for safe training and firing for each weapon system within the command.

b. Ensures all personnel within the command are briefed on and comply with installation range procedures and safety requirements including required personal protective equipment.

c. Designates an OIC and RSO for each firing exercise and/or maneuver in accordance with Table 1. (Except as designated below, the RSO may have no additional duties during the firing exercise.)

d. Ensures personnel performing duties of OIC and RSO are certified in accordance with established installation safety certification program.

e. Complies with range safety certification program guidance in MCO 3570.1B and DA PAM 385.63 for OICs and RSOs to ensure they are:

(1) Competent and properly instructed in the performance of their duties.

(2) Knowledgeable in the weapon systems for which they are held responsible and in safe ammunition handling and use procedures.

f. Develops SOPs for laser operations to include provision for immediate medical attention for personnel who incur eye or other overexposure to laser energy and reporting laser overexposure incidents in accordance with TB MED 524, MIL-HDBK 828A, and MCO 5104.1.

g. Applies risk management and develops controls and procedures for all phases of training events.

Officer in Charge (OIC):

a. **Qualifications:**

(1) Commissioned, warrant, or noncommissioned officer (NCO, U.S. Army), staff noncommissioned officer (SNCO, Marine Corps) or civilian (U.S. Army). NCOs serving as OIC will be in the grade as shown in Table 1 at a minimum.

(2) OICs will be certified in the weapon systems for which they are responsible. *(Weapon System Knowledgeable: An individual, military or civilian, who has completed a standard program of instruction for a particular weapon system or has completed familiarization training established by the installation commander. Familiarization training may involve live fire training. Proponent school should approve familiarization training.)* For weapon systems equipped or dependent on lasers, the OIC will be knowledgeable of laser hazards and proper employment. The OIC holds responsibility and accountability for the conduct of the activity and the adherence to governing regulations and guidance. He/she must be able to fully influence the conduct of the event. For aviation weapons systems, the OIC must be weapons systems knowledgeable.

(3) The OIC must have satisfactorily completed a range safety certification program. Marine Corps battalion/squadron commanders are responsible for establishing and maintaining a certification program for the OICs and RSOs commensurate to the assigned duties and responsibilities.

b. **Duties:**

(1) Ensures the overall safe conduct of training and proper use of the installation-training complex

(2) Receives a range safety briefing from installation range control organization on use of the training complex

(3) Ensures the RSO is physically present at the training site

(4) Determines when it is safe to fire in accordance with applicable regulations and installation range requirements

(5) Ensures receipt of final clearance to fire from range control

(6) Ensures proper supervision of personnel performing misfire, hang-fire, and cook-off procedures

(7) Ensures required communications are established and maintained

(8) Ensures safe laser operations

(9) Ensures adequate medical support is available

(10) Ensures ammunition and explosives are properly handled, transported, stored, and accounted for within the training complex from the time of receipt to the time of expenditure or turn-in

(11) Ensures a written log is maintained of pertinent safety and control data concerning the operation of firing ranges, weapons training facilities, and maneuver areas, authorized operating times, impact areas entries and exits, and cease-fire authorizations

(12) Ensures plans for firing exercises and maneuvers are coordinated with range control

(13) Ensures control of target areas to prohibit entry by unauthorized personnel

(14) Ensures all ammunition malfunctions and accidents are reported to range control in accordance with MCO P5102.1 and MCO 8025.1

(15) Ensures coordination and approval has been gained from the range control agency for all civilian personnel that will be entering the training site

(16) Briefs the RSO on the duties to be performed in support of the training event. Clearly establishes the requirement for the RSO to brief the OIC on the safety of the facility and unit, and the readiness to commence live-fire operations prior to the start of firing

(17) Implements operational risk management in all phases of the training events

The RSO:

a. **Qualifications:**

(1) Commissioned officer, warrant officer, NCO (Army), SNCO (Marine Corps) or civilian. For field artillery applications, the position commander or OIC may assume RSO duties. Grade requirements will be in accordance with Table 1. Personnel assigned as RSO will have no other duties during that period of training, except for aviation weapons systems training where instructor pilots may assume RSO duties. Assistant range safety officers (ARSO) may be appointed as required.

(2) Weapon system qualified. *(Weapon System Qualified: An individual, military or civilian, who has completed a standard program of instruction for a particular weapon system.)*

(3) Certification of satisfactory completion of unit or installation range safety certification program.

b. **Duties:**

(1) Receives range safety briefing from the installation range control organization on use of the ranges and training areas.

(2) Ensures before granting clearance to fire:

(a) Weapons and personnel are properly positioned.

(b) Authorized ammunition and explosives to include proper charge, fuze, and fuze settings are used.

(c) Firing settings and weapons systems are within prescribed safety limits and verified.

(d) SDZ is clear of all unauthorized personnel.

(e) Personnel within noise-hazard areas wear proper hearing protection.

(f) Personnel within eye-hazard areas wear proper eye protection.

(g) Permission is received from range control to commence training and live-fire operations.

(h) Marine Corps RSOs (Stinger) will comply with responsibilities listed in local SOPs.

(3) Prior to commencing live-fire operations, conducts final coordination with the OIC. This coordination will include a summary of checks, inspections, and actions that the RSO has completed, verification that required communications has been established, and that a "hot status" has been received from range control.

(4) Orders immediate cease-fire or check-fire when any unsafe condition occurs.

(5) Is physically present at the training site.

(6) Reports all accidents and ammunition malfunctions to the range OIC.

(7) Verifies, upon completion of firing or firing order, to the OIC that all weapons and weapon systems are clear and safe before allowing the removal of weapons from the firing area.

(8) During laser operations, the Laser Range Safety Officer (LRSO):

(a) Ensures unit personnel employing lasers receive thorough safety briefings to include explanations of specific laser-related hazards, safety equipment, and detailed range safety procedures, and complies with procedures in Chapter 18, DA PAM 385-63.

(b) Knows and observes horizontal and vertical safety limits of the laser range.

(c) Follows unit SOPs for laser operations and training exercises.

(d) Ensures all personnel engaged in laser operations, to include personnel in target areas, maintain continuous communications.

(e) Ceases laser operations immediately if communications or positive control of the laser beam is lost.

(f) Allows the LRSO, as required, to serve as the RSO.

(9) During ADA range firing with crew-served guided missiles and rockets:

(a) Receives missile and rocket firing advisory information from the senior RSO and advises the OIC accordingly.

(b) Ensures the entire range is clear of unauthorized personnel and equipment prior to firing and maintains clearance throughout the entire firing sequence.

Table 1. OIC/RSO appointment requirements

Weapon System	OIC[1]			RSO[1]		
	OFF	WO	NCO	OFF	WO	NCO
Practice hand grenades; sub-caliber training devices; laser devices; firing devices; simulators and trip flares; small arms and machineguns	X	X	E-6	X	X	E-5
Chemical agents and smokes[2, 6]	X	X	E-6	X	X	E-5
Aerial gunnery and air defense weapons; flamethrowers; live grenades, grenade launchers, and grenade machineguns; live mines and demolitions; tank and fighting vehicle cannons; recoilless rifles	X	X	E-7	X	X	E-6
Field Artillery[3]	X	X	E-7	X	X	E-6
Mortars	X	X	E-6	X	X	E-6[7]
ADA rockets and guided missiles		X			X[4]	
Direct-fire antitank rockets and missiles	X	X	E-7	X	X	E-6
Live-fire exercises using organic weapons, squad through company, battery, troop	X	X	E-7	X	X	E-6
Combined arms live-fire exercises using outside fire support, troop, battery, squad, platoon, company; or battalion and larger[5]	X	X	E-7	X	X	E-6

Notes:
1. Civilians in the grade of GS-07 or above may act as OIC, and GS-05 or above, or equivalent for RSO. Civilian contractors may act as OIC/RSO when approved by the installation commander
2. OIC and RSO must be nuclear, biological, and chemical (NBC) qualified when conducting NBC or smoke training.
3. Use of E-7s as OICs is authorized only when approved by the installation commander. Either the battery executive officer or platoon leader normally performs duties of the RSO.
4. SRSO will be a field grade officer, CW4 or CW5 (Army) or civilian in the grade of GS-12 or above.
5. OIC will be a field grade officer for battalion or larger CALFEX.
6. RSO for Marine Corps will be E-6 or above for practice hand grenades, chemical agents and smokes.
7. RSO for Marine Corps can be E-5 for mortar training activities.

Positioning and issuing ammunition and explosives

a. Ammunition and explosives (to include pyrotechnics) will be positioned to minimize the potential for ignition from external sources, explosion, rapid burning, or sympathetic detonation and will be located and stored in accordance with this pamphlet and requirements NAVSEA OP5 and MCO P8020.10A as appropriate.

b. Training situations require ammunition and explosives at various locations that are temporary or transient by nature. It is not intended that these locations require approval by the Department of Defense Explosives Safety Board (DDESB) if ammunition and explosives are in total support of a training mission. Installation and service controls will be established to ensure quantity-distance standards are applied to the extent possible.

c. Distribution of ammunition to personnel will occur only in areas designated for that purpose, for example, ammunition breakdown buildings, ready lines, firing lines, attack positions, assembly areas, or defilade positions. Blank and live-fire ammunition will not be stored in or issued from the same building at the same time. Additionally, blank and live ammunition will not be utilized or stored on ranges at the same time.

d. Fuel and ammunition re-supply operations and points shall be located a minimum of 300 meters apart. General officer installation commanders may authorize deviation from this standard based on quantity-distance (Q-D) criteria. Distances will not be reduced below the public traffic route (PTR) distance for troops in training. Forward arming and refueling point operations and separation distances for fuel, ready ammunition storage areas, and basic load storage areas will be in accordance with the applicable tactical manual. Distance will not be reduced below the PTR distance for training.

e. The quantity of ammunition unpacked at the breakdown building or firing line will be kept to the minimum number of rounds needed for efficient firing of the exercise. Packaging material, propelling increments, and fuzes will be retained until firing is complete. Units will not burn wooden containers or indiscriminately fire or dispose of ammunition to preclude its return to a storage facility. (Exception: Smoky Sam rockets, a pyrotechnic, are issued by the case with a quantity of 12 rockets and 12 igniter rods. Planning use of these pyrotechnics requires careful consideration of the effects of moisture on unpacked items. All unpacked rockets must be expended and only full, unbroken cases returned to the ammunition supply point.) Broken and/or unserviceable increments (powder bags) will be handled in accordance with installation range and environmental requirements.

f. Guided missiles, rockets and components, such as fuels, propellants, oxidizers, and explosives in ready storage or at the firing location will be positioned to minimize the possibility of ignition or detonation by motor exhaust or by an accident involving the firing of a missile or rocket. Items will be stored in dry locations, protected from direct rays of the sun, and adequately ventilated. Marine Corps Smoky Sams, Smoky Guns, and pyrotechnics will be stored as outlined in appropriate Marine Corps TMs, or Commander, Naval Air Systems Command (NAVAIR) technical publications.

g. During pre-fire preparation, guided missiles, rockets, and components will be handled and assembled in a manner consistent with this pamphlet, local range requirements, and appropriate FMs and TMs. Any alteration to guided missiles or rockets and their associated equipment is prohibited except as authorized by official publications or by CG, Army Materiel Command (AMC).

h. All ammunition, unpacked for firing but not fired, will be repackaged into its original packing configuration prior to return to the ammunition supply point.

i. Ammunition that is easily degraded by short-term exposure to moisture, such as propelling charges, pyrotechnic signals, and simulators, will be unpacked only for the minimum amount of time consistent with mission requirements.

j. Requests for current status of ammunition not listed in NAVSEA TWO24-AA-ORD-010 will be sent to NAVAMMOLOGCN, Mechanicsburg, PA, DSN 430-2107/Comm (717) 605-2107 (Marine Corps).

k. Defective ammunition will be reported in accordance with MCO P8025.1D and Ammunition Malfunction Data Collection Guide (8025) NAVMC on the following page.

Ammunition Malfunction Data Collection Guide (8025)

Ammunition that fails to perform as expected can normally be attributed to a malfunction, human error, or a weapon/equipment deficiency. In every instance, it is imperative that certain facts surrounding the matter be immediately noted and appropriately reported so that remedial action can be initiated to preclude recurrence. Attention is invited to the fact that the cognizant design agent will conduct a detailed technical investigation predicated in part on the data provided by the user in the malfunction report. To insure that the report contains the essential data, personnel on the scene must take notes on the elements enumerated below as they relate to the particular situation. MCO 8025.1 contains the specific reporting requirements.

NOTE: The following is not a complete list of the data elements required in the malfunction report but rather is limited to those elements that must be immediately noted at the scene to enhance report accuracy.

1. Note the details of what actually occurred and the actions of appropriate personnel immediately prior to the malfunction (this is essential in determining whether human error caused or contributed to the situation as a result of inattention, carelessness or deviation from standard procedures). Check for residue from the item(s) involved. If present, accumulate and retain.
2. Record time, date and weather conditions.
3. Identify the item(s) involved. FSN/DODIC and lot number of the complete item and lot numbers of the major components, if identifiable. Or, FSN/DODIC and lot number of each individual item used to make up the complete round (e.g., 155mm projectile, fuze, primer, and propellant charge).
4. Condition of the ammunition prior to use. Was item or packaging wet or discolored? Did either appear deteriorated? Was item adversely exposed to the environment? (e.g., prolonged exposure to the direct rays of the sun, exposed to rain, snow, etc.) Any indications of rough handling or unauthorized alteration/tampering?
5. Identify the weapon utilized. Model and serial number. Condition of the weapon prior to and after firing. Number of rounds fired on this date. Elevation, zone in which fired, increments used, range to target, fuze setting. Was the weapon operated properly and did it function normally? Length of recoil. Any evidence of unburned propellant or residue in the tube? Could foreign material have entered the tube prior to firing. Any indication of nonstandard conditions or practices?

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Suspension of ammunition and explosives involved in malfunctions

a. When any round or item of ammunition, explosives, or their components malfunctions, the firing unit will notify the range control office. The range control office will report the incident(s) to the installation ammunition officer. Marine Corps units will report defective ammunition in accordance with MCO 8025.1. Appropriate action will be taken as required by. Firing suspensions and restrictions are published in NAVSEA TWO24-AA-ORD-010, and appropriate technical manuals.

b. For guided missiles, rockets, or components thereof that have malfunctioned and when it is evident that personnel safety or equipment is at risk, the affected lot will be locally suspended immediately. Marine Corps will use procedures set forth in MCO 8025.1.

c. Any ammunition suspended and listed in NAVSEA TWO24-AA-ORD-010 and supplements will not be fired in training.

d. Firing of any ammunition listed in NAVSEA TWO24-AA-ORD-010 and supplements as being "restricted" will be conducted only in accordance with the restriction requirements.

Unexploded ordnance (UXO) and misfire procedures and reporting

a. The range OIC will report all UXO (dud) ammunition to the installation range control officer. In the case of grenades or other munitions that may be immediately hazardous to personnel (that is, bursting radius), firing will be halted until qualified EOD personnel clear the dud. In other cases, firing need not be halted. Duds not cleared by EOD personnel before the unit departs the training complex will be reported in writing to the installation range control officer for data compilation and determination of clearance scope.

b. Misfire procedures in training manuals for the appropriate weapon system will be followed. In the event misfires present an immediate hazard to personnel or a cease-fire is necessary, they will be reported to range control.

c. When dud and misfire rates equal or exceed the rates given in Enclosure 2 of MCO 8025.1, the affected lot(s) will be reported as a malfunction.

Disposition of ammunition and explosives involved in malfunctions and accidents

a. Materiel involved in malfunctions or accidents and any evidence such as components or fragments of the weapon system, ammunition, missile, or rocket will be carefully preserved in the position and at the location it occupied at the time of the incident. If the material has been involved in a class A or B accident, as defined in MCO P5210.1, it will remain in position until disposition is directed by the investigating authority unless immediate hazard to life or property are present.

b. Damaged or malfunctioned guided missiles and rockets will be reported per the applicable TM.

Police of the training complex

a. Removal of spent brass, unfired rounds, or components of fired rounds from UXO contaminated impact areas without the consent of the installation RCO is not authorized.

b. Dumping ammunition or explosives into impact areas or other unauthorized disposal or disposition areas is prohibited.

c. Unauthorized removal of ammunition, pyrotechnics, explosives, or residue from munitions or from the range or installation training complex is prohibited.

d. The collection of spent brass is not required when ammunition is expended from mounted or dismounted weapons over extended terrain.

Small arms firing conditions

a. Range safety information and small arms SDZs for direct fire weapons as listed in MCO-3570.1B and DA PAM 386-63 (Chapter 6, cone) are the standard. When designing ranges that involve fire and movement, or where ricochet hazards outside the range complex boundary may endanger non-participating personnel or the general public, SDZs in Appendix B (batwing) of DA PAM 385-63 should be used.

b. All personnel within the hearing hazard zone will wear approved single hearing protection. The size of the hazard zone varies with the weapon. For mixed-use ranges, it is usually convenient to establish the zone based on the loudest weapon used. For administrative convenience, the size of the hearing protection zones can be increased to encompass areas within convenient access or demarcation points. The Marine Corps requires that all personnel exposed to gunfire or artillery or missile firing, under any circumstances, will wear hearing protective devices. The following list of distances to the hazard contours for common military weapons is conservative:

(1) 0.50 caliber: 55m to the side; 12m to the rear
(2) 0.45 caliber: 12m to the side; 4.5m to the rear
(3) 9mm: 9m to the side; 6m to the rear
(4) 7.62mm: 20m to the side; 8m to the rear
(5) 5.56mm: 24m to the side; 6m to the rear

c. Approved eye protection (or eye armor) shall be worn, especially during force-on-force training maneuvers or scenarios. The installation commander may, based on risk management, reduce or eliminate requirement for eye protection, if his/her decision is that reduced vision created by use of eye protection outweighs its value.

Table 2. Minimum thickness of material for positive protection against caliber ammunition listed

Nature of Cover	Thickness, in centimeters, by ammunition caliber		
	5.56mm	7.62mm	.50 cal
Concrete (5000 psi)	12.7	17.8	30.5
Broken stone	35.6	50.8	76.2
Dry sand	40.6	61.0	81.3
Wet sand	63.5	91.4	121.9
Wire oak logs	71.12	101.6	142.2
Packed earth	81.3	121.9	152.4
Undisturbed compact earth	88.9	132.1	167.6
Freshly turned earth	96.5	142.2	182.9
Plastic clay	111.8	165.1	254.0

Overhead small arms fire

a. Overhead small arms fire above protected troops is authorized when minimum protection shown in Table 2 is provided. Table 2 shows the thickness of various materials needed to positively protect against individual projectile impacts. The material thickness will provide adequate protection against single round impacts but not automatic fire. The data shown for 5.56mm is for M193 Ball ammunition. The 5.56mm M855 Ball ammunition may have greater penetration.

b. Overhead fire above unprotected troops with small arms may be conducted when authorized by the installation commander and specifically approved by the installation range control officer.

c. Weapon systems authorized for overhead fire of unprotected troops are 5.56mm, 7.62mm, and .50 caliber machineguns on ground tripods or vehicle mounts (ring mount excluded) firing from a stationary position. Overhead fire of unprotected troops from Marine Corps high multi-purpose wheeled vehicles (HMMWV) is not authorized.

d. Only ammunition certified as cleared for overhead fire in TB 9-1300-385/NAVSEA TWO24-AA-ORD-010 will be used. Currently the only small arms ammunition certified for overhead fire is de-linked (DODIC) A151.

e. Hand-held, shoulder-fired, or flex-mounted weapon systems will not be fired over the heads of troops on infiltration courses.

f. Rates of fire will not exceed 70 rounds per minute for 5.56mm and 7.62mm machineguns and 40 rounds per minute for .50 caliber machineguns. Tracer ammunition may be used to assist in monitoring projectile paths.

g. Overhead fire with machineguns in live-fire exercises will be as follows:

(1) Firing positions for weapons delivering overhead fire will provide unobstructed field(s) of fire.

(2) Applicable ballistic tabular firing tables will be used to determine the minimum angle of elevation for all overhead fire. Projectiles will not be permitted to impact between the firing position and unprotected troops downrange. All impacts shall be at least 30m beyond the personnel most distant from the weapon.

(3) Positive stops must be used to prevent crossfire and depression of weapon systems during overhead firing.

(4) Weapon systems will be test fired before delivery of overhead fire to verify the effectiveness of positive traverse and depression stops.

(5) Minimum vertical clearance requirements: A minimum vertical clearance of 2.5m over the heads of unprotected troops or the highest obstruction within the field of fire will be maintained. This minimum vertical clearance is the distance between the lowest shot in the dispersion pattern as determined by test firing and the highest point of ground, log, or other obstacle over which troops must travel or heights of barbed wire strands or posts on the course, whichever is higher.

Flanking fire

a. Ground-mounted or vehicle-mounted small arms may be used to provide low angle flanking fire when a minimum angle of 15° between the limit of fire and exposed troops is maintained.

b. Positive means will be employed to ensure that the firing unit knows the location of the maneuver units while fire support is being provided.

c. The route and location of maneuver units and the location of the weapons providing flanking fire support will be described in detail using recognizable natural and/or manmade terrain features or other positive identification features to all involved personnel.

d. Because of the danger of lateral ricochets, flanking fire should be planned using the SDZ data (batwing) in Appendix B, DA PAM 385-63. However, if this is not feasible, the following minimum conditions apply:

(1) Weapons will be mounted on ground-mount tripods or vehicle mounts.

(2) Projectiles must not impact any closer to unprotected personnel than 100m.

(3) Only non-explosive and non-discarding sabot projectiles may be used.

(4) An angle of 15° or more must be maintained between the limit of fire and near flank of the closest individual or maneuvering unit.

Shotgun ranges

Training used for shotgun firing will be in accordance with SDZ requirements as found in DA PAM 385.63, Figure 6-1 and Table B-1.

Surface danger zone (batwing)

a. SDZ template numbers 1, 2, 4, and 5 depict the SDZ for small arms, machineguns, and shotguns firing from a single firing position along the line of fire, also known as a gun target line (GTL), to a single target.

b. When the nature or extent of training requires multiple firing positions, the SDZs in the included templates will be bisected longitudinally and the GTL expanded to accommodate multiple targets. This establishes left and right limits of fire.

c. When the nature or extent of training requires moving targets, the SDZs in the included templates will be bisected longitudinally and the GTL expanded to accommodate moving targets. This establishes the left and right limits of fire.

d. Live-fire maneuver areas requiring multiple or composite SDZs must be constructed based on each weapon, ammunition, and target engagement scenario.

Blank ammunition

a. The following precautions will be observed during the use of blank ammunition:

(1) The blank firing attachment (BFA) is a necessary component for operational safety. Weapon systems for which approved BFAs are manufactured will not be fired without the proper BFA. The distance at which weapons can be safely fired at unprotected troops without causing injury is somewhat reduced with the BFA. However, 5m safe-separation distance (SSD) will not be reduced. This distance, with a dispersion angle of 10 degrees left and right of the GTL, does not exclude

possible injury to the unprotected eye. Hearing protection (ear plugs) should be worn while firing blank ammunition.

(2) Utility uniforms offer skin protection and should be worn at all times. Firers should use eye-protection.

b. A violation of the SSD could result in serious injury. If the SSD is decreased to within .9m, fatal injuries may occur.

Batwing surface danger zones

Firing conditions for batwing SDZs

Batwing SDZs provide for greater containment of all ricochets. They should be considered when designing ranges involving fire and movement or where ricochet hazards outside the range complex boundary may endanger non-participating personnel or the general public. Where batwing SDZs have already been applied or can be employed without significant impact on range operations, the batwing SDZs should be implemented.

Surface danger zone

a. SDZ template numbers 1, 2, 4, 5 depict the SDZ for small arms, machineguns, shotguns, and other direct-fire weapons without explosive projectiles firing from a single firing position along the GTL to a single target.

b. SDZ template numbers 6 and 7 depict the SDZ for direct-fire weapons with explosive projectiles firing from a single firing position along the GTL to a single target.

c. When the nature or extent of training requires multiple firing positions, bisect the GTL longitudinally and expand the GTL to accommodate multiple targets. This establishes left and right limits of fire.

d. When the nature or extent of training requires moving targets, bisect the GTL longitudinally and expand the GTL to accommodate moving targets. This establishes left and right limits of fire.

e. Table 3 provides SDZ dimensions with corresponding deflection values (area *W*, angles *P* and *Q*) for engaging various target media, earth, water, steel, or concrete for small arms, machine guns, shotguns, and other direct-fire weapons without explosive projectiles.

Table 3. SDZs for direct-fire weapons without explosive projectiles

Caliber	Impact media	Dist. *X* (Meters)	Dist. *Y* (Meters)	Area *W* (Meters)	Vertical hazard (Meters)	Angle *P* (Degrees)	Angle *Q* (Degrees)
12-gauge slug	Earth/Water	1073	710	125	136	21.96	33.34
	Steel/Concrete	1073	830	287	197	56.91	40.17
.22 cal Long Rifle, M24	Earth/Water	1400	1033	155	96	24.00	15.90
	Steel/Concrete	1400	1125	386	245	63.40	30.30
.38 cal M41 Ball	Earth/Water	1806	1110	153	89	22.57	16.07
	Steel/Concrete	1806	1258	389	245	60.95	35.36
9mm M882 Ball	Earth/Water	1800	1077	158	93	23.10	15.80
	Steel/Concrete	1800	1211	399	253	61.10	30.40
.45 cal, M1911 Pistol/SMG	Earth/Water	1690	1016	117	100	21.11	16.69
	Steel/Concrete	1690	1111	290	186	54.74	30.77
5.56mm, M193 Ball	Earth/Water	3100	2004	458	319	35.20	23.10
	Steel/Concrete	3100	1666	323	219	19.00	26.90

Caliber	Impact media	Dist. *X*	Dist. *Y*	Area *W*	Vertical hazard	Angle *P*	Angle *Q*
		(Meters)				(Degrees)	
5.56mm, M196 Tracer	Earth/Water	3100	2066	362	355	35.10	26.80
	Steel/Concrete	3100	2023	243	243	19.20	22.80
5.56mm, M855 Ball	Earth/Water	3437	2029	462	325	34.20	22.40
	Steel/Concrete	3437	1810	334	229	18.80	25.20
5.56mm, M856 Tracer	Earth/Water	3089	1607	355	261	32.80	23.20
	Steel/Concrete	3089	1592	277	261	18.60	21.00
5.56mm, M862 Plastic	Earth/Water	250	165	24	16	15.40	20.00
	Steel/Concrete	250	136	5	4	3.30	7.30
7.62mm, M118 Special	Earth/Water	5288	4800	1545	752	43.81	38.73
	Steel/Concrete	5288	5137	990	490	20.17	41.29
7.62mm, M80 Ball	Earth/Water	4100	4073	1461	706	43.54	38.90
	Steel/Concrete	4100	4053	861	447	20.04	75.54
.50 cal, M858 Ball, Plastic	Earth/Water	700	398	20	41	4.28	9.16
	Steel/Concrete	700	415	53	41	11.65	21.14
.50 cal, M860 Tracer, Plastic	Earth/Water	700	398	20	41	4.28	9.16
	Steel/Concrete	700	415	53	41	11.65	21.14
.50 cal M2 AP	Earth/Water	6100	5142	1659	904	40.80	69.60
	Steel/Concrete	6100	4300	718	462	16.30	33.10
.50 cal M2 Ball	Earth/Water	6500	5211	1652	901	38.19	63.35
	Steel/Concrete	6500	4147	714	478	16.03	44.13
20mm, M220 TP-T	Earth	3940	3340	581	317	25.83	22.83
	Water	3940	3040	558	311	26.08	30.96
	Steel	3940	3290	804	513	36.66	47.76
	Concrete	3940	3260	765	447	34.33	34.09
20mm, M55A2 TP	Earth	4500	3780	733	357	25.74	33.20
	Water	4500	3500	737	350	26.16	36.66
	Steel	4500	4053	1025	585	38.14	36.82
	Concrete	4500	3750	969	509	34.12	37.78
30mm, M788 TP-T	Earth	4020	3116	636	311	24.93	40.37
	Water	4020	3252	730	298	25.19	28.65
	Steel	4020	3631	1023	524	36.78	33.18
	Concrete	4020	3600	874	451	30.66	35.59

Table 3a. SDZ for direct-fire weapons with explosive projectiles

Caliber	Impact media	Dist. *X*	Dist. *Y*	Area *W*	Vert. Hazard	Area *A*	Area *B*	Angle *P*	Angle *Q*
		(Meters)						(Degrees)	
20mm, M246 HEI-T-SD	Earth	4230	3537	685	360	156	156	26.73	39.83
	Water	4230	3316	716	354	156	156	25.81	35.87
	Steel	4230	3937	991	590	156	156	38.63	38.58
	Concrete	4230	3758	952	531	156	156	34.99	50.31
20mm, M56a3 HEI	Earth	4250	3940	864	403	156	156	26.89	34.54
	Water	4250	3980	1219	396	156	156	27.21	40.82
	Steel	4250	4160	771	664	156	156	38.36	58.05
	Concrete	4250	4240	1189	577	156	156	34.65	43.79
30mm, M789 HEDP	Earth	4122	3305	654	318	275	275	25.37	39.65
	Water	4122	3263	746	302	275	275	24.71	34.53
	Steel	4122	3947	1058	534	275	275	36.26	39.59
	Concrete	4122	3684	886	460	275	275	31.56	42.14

Hand grenades

a. **High explosive, loaded-type grenades (M67)**

(1) These contain explosive charges that detonate after a short delay (3 to 5 seconds). Every precaution will be taken to prevent injury from flying fragments. For training purposes, fragmentation and offensive hand grenades will be thrown from a trench or barrier equivalent to a screen of sandbags 0.5m thick. When throwing bays are used for protection, they will be built to a minimum height of 1.5m and wide enough to accommodate one thrower and one ARSO. Bay height may be reduced to less than 1.5m if approved by the installation commander. However, it must provide positive protection against high-velocity, low-angle fragments. (See MIL HDBK 1027/3B for other dimensions and additional information.) Throwing bays will be separated from adjacent bays by a distance of 20m. If this requirement cannot be met, separation between throwing bays may be by physical barriers (that is, earthen berms, concrete walls, or wooden revetments) long and high enough to attenuate high-velocity, low-angle fragments.

b. **Firing conditions for fragmentation and offensive grenades**

(1) Personnel within the 150m-danger area when casualty-producing hand grenades are thrown will wear approved protective helmets, protective body armor (flak jackets), single hearing protection, and proper eye protection.

(2) Safety clips on fragmentation and practice grenades will not be removed until immediately before the safety pin is removed. Once the safety pin has been pulled, the grenade will be thrown. No attempt will be made to reinsert the safety pin or tape the safety lever (spoon). The safety lever will not be released for any reason on HE grenades until the grenade exits the throwing hand at the command of the ARSO.

(3) All personnel must be proficient in the safety precautions for handling and throwing grenades before live grenade training begins. Successful completion of practice grenade training (usually referred to as mock bay) is mandatory prior to live grenade training.

(4) OIC, RSOs, and live bay ARSOs for live grenade training events must be certified to perform these duties. Certification will include training detailing actions in the event of a dropped grenade, short throw, grenade thrown other than

downrange, SDZ, control of observers, misfire/dud grenade procedures, arming, throwing techniques, and pre-live bay requirements. Marine Corps battalion and squadron commanders are responsible for establishing and maintaining a certification program for their OICs and RSOs commensurate to the assigned duties and responsibilities. Marines Corps battalion and squadron commanders are responsible for certifying OICs and RSOs.

(5) High explosive grenades that fail to function (dud) will not be approached except by EOD personnel. During training, if a grenade fails to explode, the throwing of live grenades in any bay within the uninterrupted fragmentation radius of the dud grenade will cease. Only EOD personnel will destroy dud grenades. Unauthorized personnel will not approach, move, touch, or handle dud grenades.

(6) During demonstrations, fragmentation and blast/concussion type grenades will be thrown from a barricaded position so grenades burst at least 150m from unprotected personnel.

(7) When direct viewing of hand grenade detonations is required within the 150m-danger area, composite (laminated) viewing ports will be used.

(a) Viewing ports will be constructed to the following criteria or equivalent:

1. 10mm glass (outside)
2. 7mm polycarbonate
3. 6mm glass
4. 6mm polycarbonate
5. 6mm glass
6. 6mm polycarbonate

(b) These criteria provide minimum essential one-time protection against worst-case fragmentation detonated within 6m of the viewing port. Additionally, 12.7mm or equivalent exterior polycarbonate protective sheet (scar shield) should be installed in front of the viewing port. The shield absorbs the majority of damage and is more easily replaced than the entire viewing port.

(8) Live grenades will not be thrown into standing water, deep snow, or dense vegetation.

(9) When training with live grenades in a tire house, trench line, or like environment and a dud grenade is experienced, all activities within the structure or danger area will stop, personnel will remain within a safe area for a minimum of 5 minutes and then evacuate the structure or area until EOD clears the dud.

(10) Range cadre and commanders are cautioned that multiple employments of grenades in a training scenario significantly increase the difficulty of determining the actual number of grenades that detonated. Dud grenades may be activated by subsequent training and generate an unplanned detonation.

(11) The use of hand grenades during live-fire exercises shall conform to the provisions provided by Chapter 19, DA PAM 385.63.

(12) For the DWBS, MK141 Mod O grenade, see TECOM SOUM 2-03

c. **Firing conditions for chemical and incendiary hand grenades**

(1) Chemical grenades will not be held in the hand after the safety lever is released. The incendiary hand grenade may be taped or tied in place if the incendiary effect is desired at a specified location. In this case, safety pins will not be pulled from the grenade until the desired time of functioning. Remote safety pin removal is preferred.

(2) Burning type grenades (riot control, smoke, and incendiary) are ignited by pulling the safety pin and releasing the safety lever. After the safety pin has been pulled,

the safety lever will not be released until the grenade exits the throwing hand. Once the safety lever is released, there is no way to stop the grenade from functioning. When the burning type grenade is fired in place, the firer will keep his/her face turned away from the grenade. After releasing the safety lever, the firer will quickly move at least 10m away to avoid contact with incendiary particles and fumes emitted during burning.

(3) Personnel will be instructed on the proper method of holding the M25 bursting type, riot control grenade before commencing training exercises. The arming sleeve will remain depressed until the grenade is thrown. M25 grenades will not be thrown closer than 25m to unprotected personnel.

(4) Burning type grenades burn oxygen. Standard protective masks filter particles but will not supply oxygen. Therefore, burning grenades will not be used in enclosed or confined spaces (such as occupied tunnels) or in other confined spaces into which personnel will enter until those spaces are ventilated. Specific fuze burning delay times and functioning characteristics are in TM 9-1330-200-12 and TM 43-0001-29. (See paragraph 16-3, DA PAM 385-63 for safety of use data for chemical smoke.)

(5) Burning type CS grenades will not be fired closer than 10m to other personnel or 50m to spectators upwind.

(6) M8, Hexachloroethane (HC) smoke grenade restrictions are the same as those for HC smoke pots. These grenades will ignite combustible materials and will cause burns. A separation distance of at least 10m should be maintained from burning grenades. Personnel will wear protective respirators or masks before exposure to any concentration of smoke produced by M8 white smoke grenades. (See Chapter 16, DA PAM 385-63, for detailed information concerning smoke hazards.)

(7) Burning particles of white phosphorous are frequently projected from the M34 grenade to a distance of 40m from the bursting point. Therefore, M34 grenades should be thrown only on standard live grenade ranges during training as prescribed in FM 3-23.30. White phosphorous particles cause serious, painful, slow-healing burns.

(8) Direct viewing of thermite grenades will not be conducted due to the high potential of permanent eye damage.

d. **Surface danger zones**

(1) Surface danger zone requirements for hand grenades are provided in Figure 7-1, DA PAM 385-63.

Grenade launchers and grenade machineguns

a. **General firing conditions**

(1) Personnel will be instructed in the proper use of grenade launchers and grenade machineguns and applicable safety precautions before firing with live ammunition.

(2) All duds will be reported by the OIC to the range control office. When fired or launched HE grenades cannot be cleared from an impact area, the impact area must be designated as a dedicated, high-hazard impact area. Dedicated high-hazard impact areas will be fenced off and posted with signs to warn and keep out unauthorized personnel.

b. **Firing precautions for M79/M203 grenade launchers**

(1) Hazardous fragmentation from HE grenade ammunition may be experienced to 165m from the point of detonation. Appropriate HE no-fire lines will be

established. Training practice (TP) ammunition, M781, does not require areas *A* or *B*.

(2) Although 40mm grenade launchers M79 and M203 are designed to prevent accidental chambering of 40mm high-velocity ammunition, OICs and RSOs will ensure only low-velocity grenade cartridges are fired from M79 and M203 grenade launchers.

(3) Single hearing protection will be worn within 2m of firing these grenade launchers. A helmet and flak jacket must be used while conducting firing of HE M203 40mm grenades.

(4) Snow depth of 10cm or more and standing water will increase the potential of 40mm duds. These conditions must be considered prior to firing.

c. **General firing precautions for machinegun, MK19, MOD 3**

(1) Targets will be engaged only at ranges greater than 75m with TP ammunition.

(2) Targets will be engaged only at ranges greater than 310m with HE ammunition.

(3) Firing through obstructions will be avoided.

(4) Personnel within a 310m radius of impact point will wear protective helmet, body armor/flak jacket, and ballistic eye protection at all times.

(5) Range firing procedures and physical setup must be adequate to prevent rounds from impacting closer than 310m from the firing vehicle, other vehicles, or personnel.

(6) Firing over open hatches is not authorized. Serious injury can result from burns caused by weapon flash or by expended or ejected cartridge cases striking personnel.

(7) Approved single hearing protection is required for all personnel within the noise hazard contour of a 20m radius of the weapon system. Eye protection should be worn.

(8) Daily exposure limit within the noise hazard contour is 1,000 rounds per day.

d. **Static firing restrictions for vehicle mounted machinegun, MK19, MOD 3**

(1) A gunner's quadrant and/or MK64, MOD 7 mount depression stop will be used to keep the minimum elevation above 30 mil when firing.

(2) M998T interim squad carrier:

(a) Soft tops must be installed over the drivers and passenger compartments for safe operation of the vehicle when firing the MK19.

(b) Visual inspection of the adaptive engineering team collar-mounting bolts must be performed prior to, during, and after firing operations. All bolts must be present with nuts firmly tightened prior to firing.

e. **Moving firing restrictions for machinegun, MK19, MOD 3.**

(1) To preclude unintentional impacts of HE and HEDP ammunition at ranges less than 310m:

(a) Restrict speeds to not greater than 16km per hour when firing from the HMMWV M1025/1026 armament carrier and the M998T interim squad carrier over paved and improved roads that are in good condition, and not greater than 8km per hour over rough roads, trails, and cross country.

(b) Restrict speeds to not greater than 16km per hour when firing from the M113 and M106 family of armored carriers, and the M88A1 tracked recovery vehicle over roads, trails, and cross country.

f. **Surface Danger Zone**

(1) SDZ requirements for M79 and M203 grenade launchers are provided in SDZ Template 6. A minimum separation distance of 6m is required between firing positions. Cartridge M433 requires an area *A* and *B* of 165m. All other M79 and M203 HE cartridges require 130m as illustrated in Figure 7-2, DA PAM 385-63.

(2) SDZ criteria for the machinegun, MK19, MOD 3 are shown in Table 4 below. Minimum target engagement range for HE cartridges is 310m. Surface danger zone dimensions for 40mm machinegun, MK19, MOD3

Table 4. Surface danger zone dimensions for 40mm machinegun, MK 19, MOD 3

Cartridge	Impact Media	Distance *X*	Distance *Y*	Area *W*	Area *A*	Area *B*	Angle *P*	Angle *Q*
		(Meters)					(Degrees)	
M383	Earth	2,095	1,250	167	310	310	23	15
HE	Armor	2,095	1,250	471	310	310	60	28
M385A1	Earth	1,984	1,250	167	N/R	N/R	23	15
TP	Armor	1,984	1,250	471	N/R	N/R	60	28
M430	Earth	2,037	1,250	167	310	310	23	15
HEDP	Armor	2,037	1,250	471	310	310	60	28
M918	Earth	2,095	1,250	167	N/R	N/R	23	15
TP	Armor	2,095	1,250	471	N/R	N/R	60	28

Legend for Table 7-1:
N/R = Not required

Antitank rocket firing conditions

a. All loading and unloading for separate loading rockets (for example, 35mm, M73, practice rocket and 66mm M74 incendiary rocket) will be on the firing line with the muzzle pointed downrange. Procedures and precautions in appropriate FMs and TMs will be observed in all preparation and firing operations.

b. Personnel will not stand or have any portion of the body directly in front of or behind a loaded rocket launcher.

c. Before firing, the SDZ to the rear of the launcher (area *F*) will be cleared of personnel, materiel (including expended cartridge cases), and readily combustible vegetation. Area *F* for antitank rockets is an isosceles triangle with the apex at the breech and the width of the triangle corresponding with a rearward extension of the gun target line.

d. Prone or foxhole firing of HE AT4 (M136) is not authorized. In training, an individual may fire one round from the sitting position or three rounds from the standing or kneeling positions in a 24-hour period.

Mortar firing conditions

a. Firing mortars over the heads of unprotected troops by Marine Corps units is not authorized. Overhead fire is allowed when soldiers are in tanks with hatches closed 100 meters or more from the line of fire.

b. Marine Corps personnel participating in mortar firing will wear flak jackets and approved protective helmets.

c. Propellant increments removed from rounds before firing will be placed in metal or wooden covered containers located outside the firing vehicle or positioned a distance of at least 25m from the firing point when firing dismounted.

d. Marine Corps will observe restrictions in TM 08655A-10A for light armored vehicle-mortar variants.

e. The target engagement distance will not be less than the distance required for area *B* of the respective caliber of mortar to be fired from protected positions.

f. Unused powder increments must be safeguarded and handled in accordance with installation range and environmental regulations.

Mortar surface danger zones

a. Surface danger zone requirements for 60mm, 81mm, 4.2-in, and 120mm mortars are provided in Table 5.

b. Distance *X* will not be less than the maximum range of the greatest charge to be fired.

c. Basic dimensions of the impact area will be computed as specified in Table 6.

d. Firing table probable errors corresponding to the maximum range of charge employed will be used for this computation. These basic dimensions are based on standard conditions. They do not compensate for errors or nonstandard conditions.

e. To compute the probable errors in range and deflection, multiply the constant (listed in the SDZ diagram) by the data found in the tabular firing tables. These data are drawn in meters from the downrange edge of the target area for PED and PER.

f. When firing ammunition with explosive warheads at distances equal to or less than the lateral hazard area (area *A*), the angle between the weapon target line/lateral limits and the firing point will increase by the width of area A.

Table 5. Mortar surface danger zone criteria, in meters[1, 2, 3]

Caliber	Area *A*	Area *B*
60mm	250	300
81mm	400	400
4.2-in	400	500
120mm	600	600

Notes:

1. Quadrant elevation limits must be modified to take into account the distance to the minimum and maximum limits of the impact area. After registration, corrections must be applied to the deflection quadrant elevation limits. When firing the 4.2-in mortar, if registration firing is not conducted, metro and velocity error corrections will be applied to these limits, or all targets will continue to be selected in the central portion of the impact area.
2. Dimensions of areas *A* and *B* may be reduced by 50% when firing illumination cartridges.
3. Cartridges without HE filler (for example, M880, M931) do not require areas *A* and *B*.

Table 6. Basic impact area dimensions

Limits	Dimensions
Left	Eight deflection probable errors (PE_D) from the left limit of target area
Right	Eight (PE_D) from the right limit of target area
Far edge	Eight range probable errors (PE_R) from the far edge of target area

Fundamentals of laser range safety

The fundamental concept of laser range safety is to prevent direct and collateral injury or damage resulting from laser use. Personnel using or supervising the use of lasers must be thoroughly familiar with all aspects of laser operations and associated dangers. The following guidelines will be used in conjunction with the guidance provided in referenced publications when employing lasers.

a. MIL-HDBK-828A and MCO 5104.1B are definitive guidance for laser operations, characteristics, and general procedures. MIL-HDBK-828A may be ordered from the following address: Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

b. Tactical lasers will be treated as direct-fire weapons. Precautions associated with direct-fire weapons shall be applied to all lasers operated on military ranges.

c. RCOs will establish boundaries for laser range operations and strictly control laser use in training to conform to the provisions of this pamphlet and applicable TMs. Deviations may be approved after applying risk management techniques, minimizing hazards and accepting the residual risk at the appropriate command level. Reduced SDZs for lasers terminated within the range boundary do not require deviation.

d. MCO 5104.1B outlines general laser radiation safety requirements. A laser safety orientation will be given to all personnel who use or work with laser devices to include an explanation of hazards and safety requirements before they commence laser operations.

TECOM safety-of-use memorandums (SOUMS)

To address the Marine Corps unique range safety requirements, CG, TECOM will publish TECOM SOUMS. These will be directive in nature and will apply to the total force. SOUMS will remain in effect until changed or rescinded by CG, TECOM (C465).

TECOM SOUM 1-02: 9mm Cartridge Special Effects Small Arms Marking System (SESAMS)

TECOM SOUM 2-02: Use of Steel Reactive Targets (SRT) at Close Ranges with Small Arms

TECOM SOUM 1-03: Shoulder-Launched Multi-Purpose Assault with Novell Explosive Warhead (SMAW-NE)

TECOM SOUM 2-03: Diversionary Charge MK 141 (DoDIC DWBS)

For the complete list of TECOM SOUMS, refer to: http://rtam.tecom.usmc.mil.

Operational Risk Management Worksheet

Operational Risk Management Matrix
Example

Training Evolution:	Organization:	Prepared By:	Date:

Operational Phase	Hazard	Causes	Initial RAC	Develop Controls	Residual RAC	How to Implement	How to Supervise

Hazard Severity
I **Catastrophic**: Death, permanent disability, major property damage
II **Critical**: Permanent partial disability, major system or minor property damage
III **Marginal**: Minor injury, minor system or property damage
IV **Negligible**: First aid, minor system repair

Mishap Probability
A Frequent
B Likely
C Occasional
D Unlikely

Risk Assessment Code (RAC)
1 Critical
2 Serious
3 Moderate
4 Minor
5 Negligible

RAC Assessment Code Matrix

HAZARD SEVERITY	Mishap Probability A	B	C	D
I	1	1	2	3
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	5

Command Review/Approval

OIC: _____

XO: _____

CO: _____

RCO: _____

Range Live-Fire Safety Brief (sample)

a. This is your range _____ safety brief.

b. The Officer in Charge (OIC) is _____.

c. The Range Safety Officer (RSO) is _____.

d. The four weapons safety rules are:

(1) Treat every weapon as if it were loaded.

(2) Never point your weapon at anything you do not intend to shoot.

(3) Keep your finger straight and off the trigger until you are ready to fire.

(4) Keep your weapon on "safe" until you are ready to fire.

e. The misfire pit is located _____ (if required).

f. Safety is paramount. **Safety will always be priority NUMBER ONE**. No movement on the range will be permitted before informing the RSO. All road guards will be briefed and placed by the RSO only. Anyone departing or entering the range will notify the RSO before doing so.

g. Everybody is a safety officer. If you observe a situation that you feel is unsafe, call an immediate **cease-fire** (check fire for mortars) or **stop** (for individuals, Javenlins, SMAWs, blasting caps). A cease-fire must be given verbally and physically by giving the hand-and-arm signal to cease fire. In the case of a cease-fire, all weapons will go to Condition 4. Do not wait to be told. OIC/RSOs will check the backblast area to ensure it is properly cleared.

h. During firing, the ROIC will be located _____ and the RSO will be located _____. The corpsman will be located _____.

i. The dedicated safety vehicle is located _____. The safety driver is _____. Strip map to hospital. Vehicle keys are located _____.

j. MEDEVAC will be handled by the safety corpsman and the OIC or RSO in conjunction with Range Control. All other personnel will stay clear of the emergency. (Go over routes to hospital or nearest LZ.) Muster at the assembly area for accountability.

k. Duds (UXO) (are/are not) found on this range. Do not pick up, kick, or hit any ordnance on this range. Notify the RSO immediately of possible dud locations. Dud procedures for this range are as follows: _____.

l. There (will be/will not be) maneuvering on this range. If a Marine is within 15 degrees of your muzzle, **DO NOT FIRE**. Be aware of your position and the Marines around your position. If you are in doubt of the situation, **DO NOT FIRE**.

m. Overhead fire (is/is not) authorized for this range. The overhead firing procedures for this range are as follows: _____.

n. If you should encounter a stoppage, apply immediate action and, if necessary, remedial action and complete the drill. Continue with the drill until you hear the command to cease-fire or stop at which point you will comply unless told to do otherwise by a safety officer. (Go over immediate action for all weapons being fired on the range. If you should hear or feel an audible pop, immediately cease fire and notify your OIC or RSO. *An audible pop is a strange noise made when a primer detonates but fails to ignite any or all of the propellant. The primer has enough power to kick the*

projectile out of the case and if a small portion of the propellant ignites, it can lodge the projectile partway down the barrel.)

o. The uniform for this range is _____.
Hearing protection (is/is not) required on this range while conducting live fire.

p. Observe the downrange area. Your left lateral limit is _____, your right lateral limit is _____. Your internal lateral limits are the left and right of your targets. Your limit of advance is _____. All of your rounds will impact in this SDZ. You will fire on your designated targets only. Muzzles will be pointed in a safe direction at all times.

q. The only types of ammunition that will be used on this range are _____.
Note: Brief any notice of ammunition re-classification or ammunition information notice. Information of this type will be in a message.

r. The weapons to be used on this range are _____. (Go over the condition codes for all weapons to be fired.)

s. Are there any left-handed shooters (or throwers for hand grenades)?

t. Does anybody wear glasses or contact lenses that does not have them?

u. Brief any local range regulations that might apply.

v. The designated smoking area is _____. Smoking is not allowed near ammunition.

w. Helmets, flak jackets, and hearing protection will be properly worn and used.

x. Ammunition issue point is located _____ and ammunition is properly stored and guarded.

y. No cross-range firing.

z. This concludes the range safety brief. Are there any questions?

aa. Continually check range impact area to ensure it is clear of all personnel and equipment. Be sure to check for low-flying aircraft and helicopters.

bb. Shakedown of all personnel will take place to ensure 100% accountability of ammunition.
Note: Expenditure reports for ammunition will be filled out after the shakedown.

cc. All ammunition dunnage will be taken _____. Ensure it is separated.

dd. Report all Marines trained, ammunition expended, by type, to Range Control. Officer-in-Charge and Range Safety Officer.

OIC/RSO Sample Checklists

Administrative tasks

____ Ensure all range flags are up and red lights are set.

____ Ensure gates are secured or manned, if necessary.

____ Read SOP

Ensure all targets are set up.

_____ targets in stands.

Target type _____.

____ Establish solid/dual communication with range control via radio.

____ Assign person to prepare ammo for issue for all relays.

__ Rounds per shooter

__ Relays

____ Ensure the range is laid out correctly:

___ Range perimeters are within the SDZ.

___ Target line is in correct location; spot check.

___ Firing lines are in the correct location.

___ Ammo issue point is in the correct location.

___ First aid kit is in the correct location.

Pre-fire tasks/briefs

____ Count off and assign relays, if necessary.

____ Conduct a complete safety check **(clear extra weapons!)**.

____ Prepare weapons for firing.

____ Brief the ammo SNCO/NCO: _____ will be the ammo NCO. Ammo NCO will break ammo down into ____ piles of ____ rounds each with one set of earplugs per pile. Ammo NCO will also be responsible for the first aid kit.

____ OIC/RSO will read all local range regulations before firing.

____ Brief the course of fire.

____ Brief the conduct of fire.

____ Brief the medical emergency plan.

____ Brief the range-specific environmental policies and issues.

____ Read the local safety brief.

Shooter briefs

Brief 1: Appointments

____ The OIC is _____.

____ The RSO is _____.

____ The safety supervisors are _____.

____ The Ammo SNCO/NCO is _____.

____ The corpsman is located _____.

____ The safety vehicle and driver are located _____.

Brief 2: Range layout

Note: Read all local range regulations before firing.

____ Brief the left and right limits of range.

____ Brief the location of the ammo issue point.

____ Brief the location of the first aid kit.

System of work

____ Brief the scoring system.

____ Brief the ammo issue.

____ Brief road guard positions. Note: Road guards should be positioned in pairs.

Duties during live fire (sample)

____ Ensure that shooters are wearing ear protection.

____ Brief the details of each drill. Explain each drill before it is fired.

____ Follow the course of fire. Do not deviate.

____ Conduct the shoot safely. **As always, safety is paramount.**

____ Check for errors and corrections. Ensure that SNCOs/NCOs conduct proper checks and use correct coaching techniques.

____ Conduct radio checks.

After-firing duties (sample)

____ Police call

____ Conduct a complete safety check.

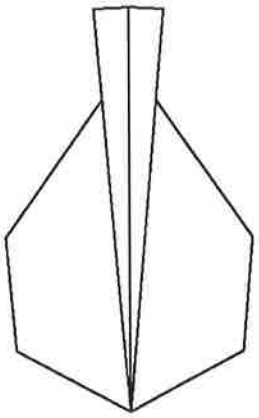
____ Unload, show-clear. Do not forget about extra weapons.

____ Ensure details are appointed to take down targets, police call, etc.

____ Return range property.

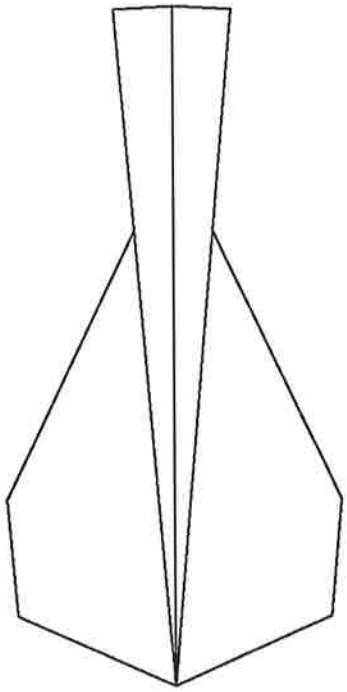
____ Take down range flags. Regroup at a convenient location.

SDZ Templates



12 Gauge Slug

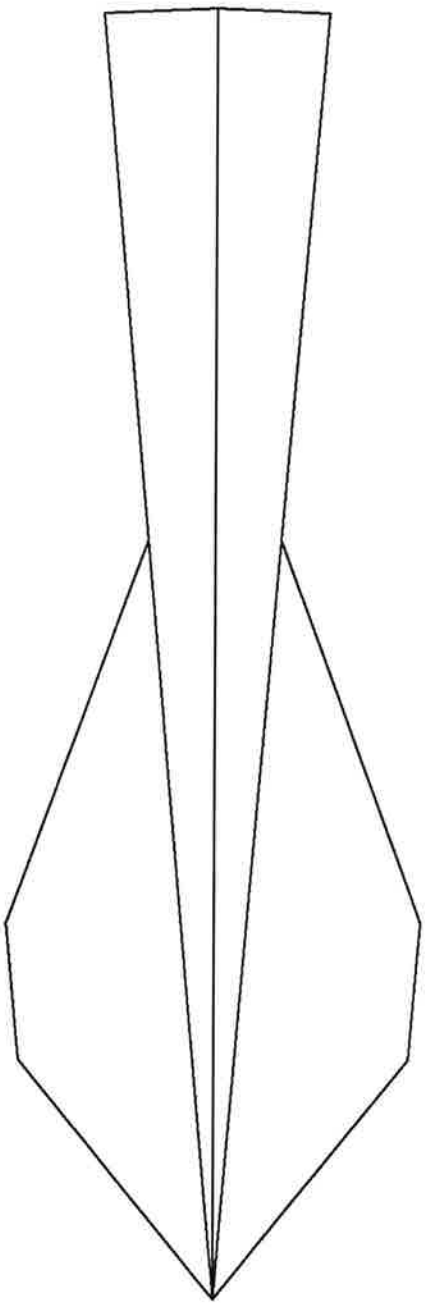
Scale: 1:25,000
Distance X: 1,073m
Impact Media: worst case
Vertical Hazard: 197m



M9 9mm M882

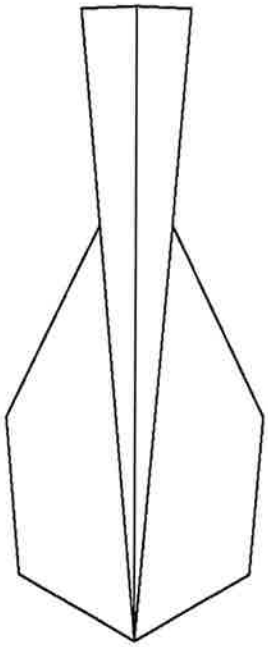
Scale: 1:25,000
Distance X: 1,800m
Impact Media: worst case
Vertical Hazard: 253m

SDZ Templates



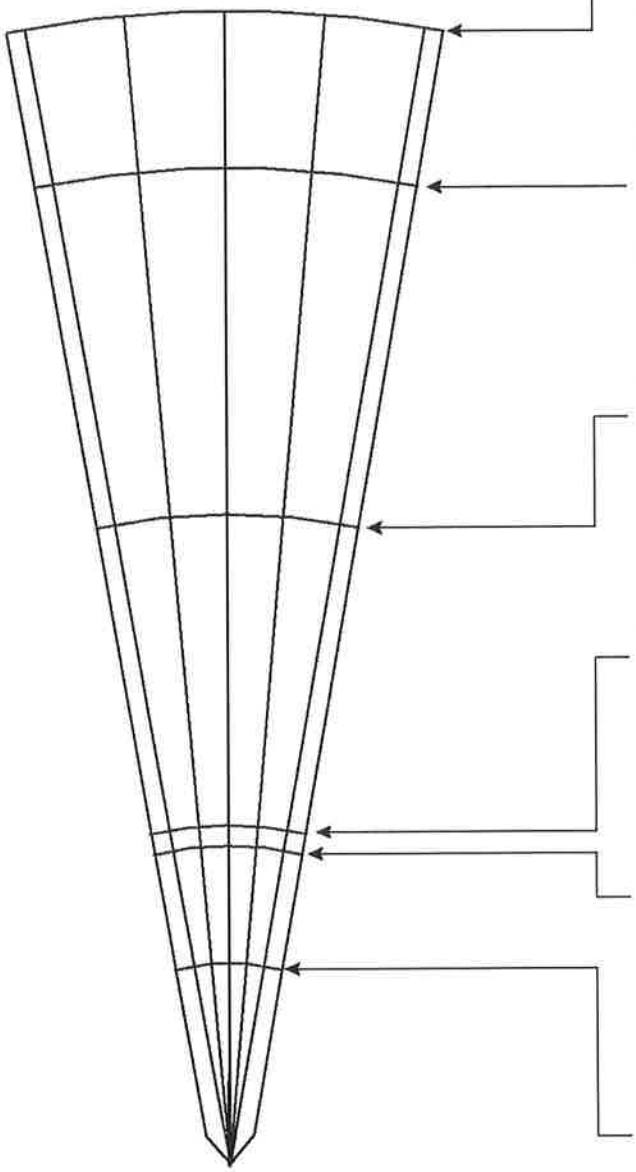
5.56mm M855 Ball

Scale: 1:25,000
Distance X: 3,437m
Impact Media: worst case
Vertical Hazard: 325m



.45 Cal Ball

Scale: 1:25,000
Distance X: 1,690m
Impact Media: worst case
Vertical Hazard: 186m



.50 Cal AP M2
Scale: 1:50,000
Distance X: 6,100m
Impact Media: worst case
Vertical hazard: 904m

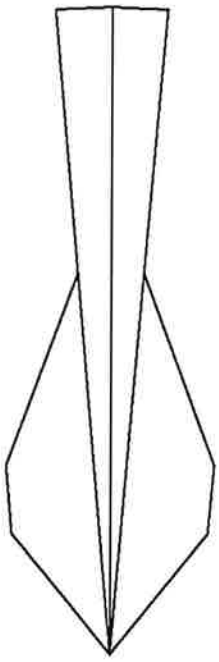
7.62mm Special Ball M118
Scale: 1:50,000
Distance X: 5,288m
Impact Media: worst case
Vertical hazard: 752m

5.56mm M855 Ball
Scale: 1:50,000
Distance X: 3,437m
Impact Media: worst case
Vertical hazard: 325m

9mm Ball M882
Scale: 1:50,000
Distance X: 1,800m
Impact Media: worst case
Vertical hazard: 253m

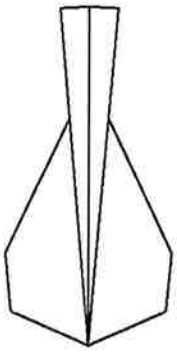
.45 Cal Ball
Scale: 1:50,000
Distance X: 1,690m
Impact Media: worst case
Vertical hazard: 186m

12 Gauge Slug
Scale: 1:50,000
Distance X: 1,073m
Impact Media: worst case
Vertical hazard: 197m



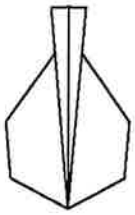
5.56mm Ball M855

Scale: 1:50,000
Distance X: 3,437m
Impact Media: worst case
Vertical Hazard: 325m



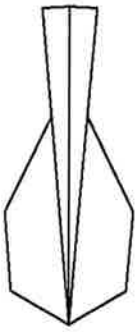
M9 9mm M882

Scale: 1:50,000
Distance X: 1,800m
Impact Media: worst case
Vertical Hazard: 253m



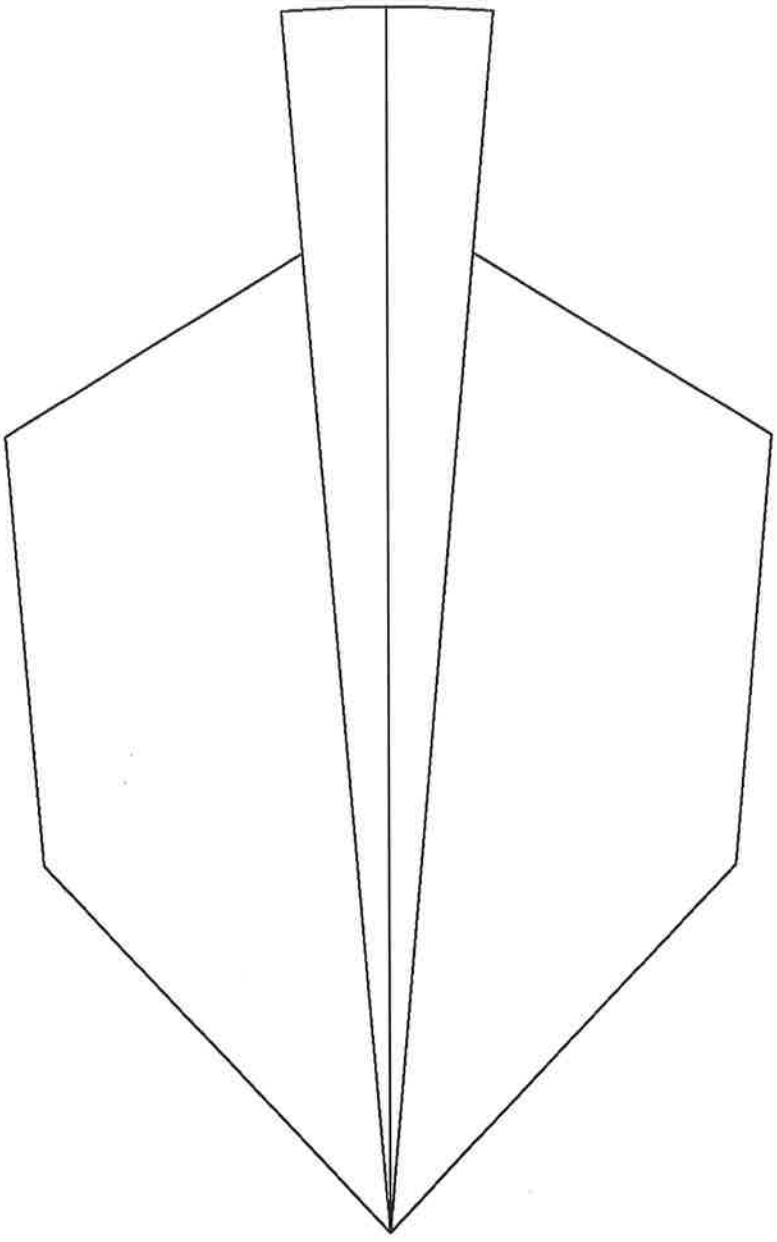
12 Gauge Slug

Scale: 1:50,000
Distance X: 1,073m
Impact Media: worst case
Vertical Hazard: 197m



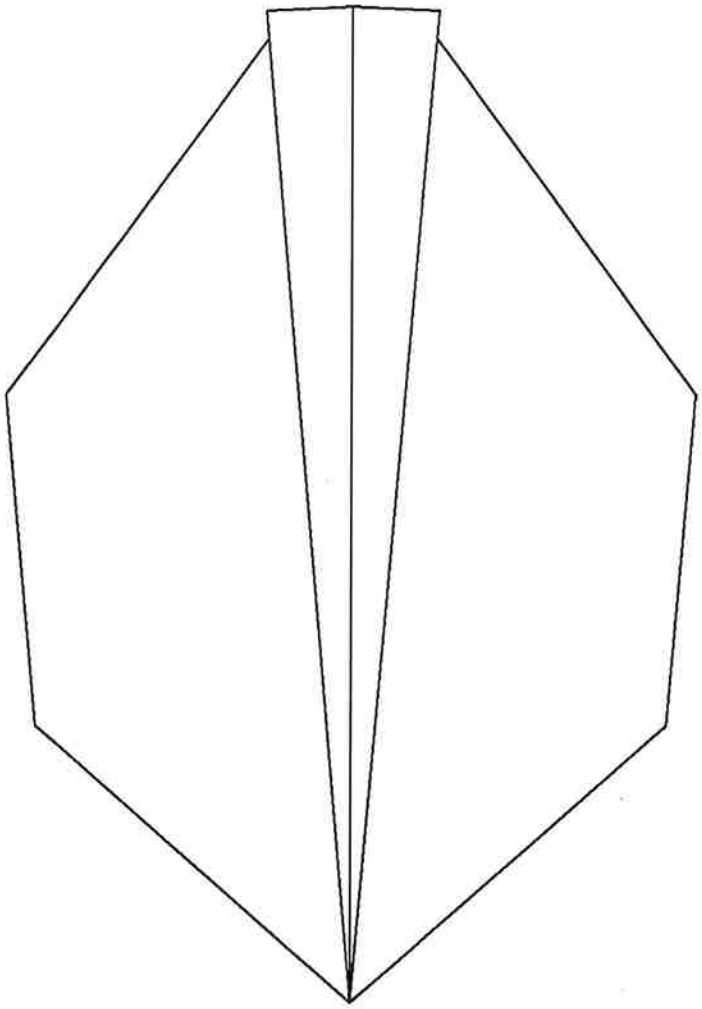
.45 Cal Ball

Scale: 1:50,000
Distance X: 1,690m
Impact Media: worst case
Vertical Hazard: 186m



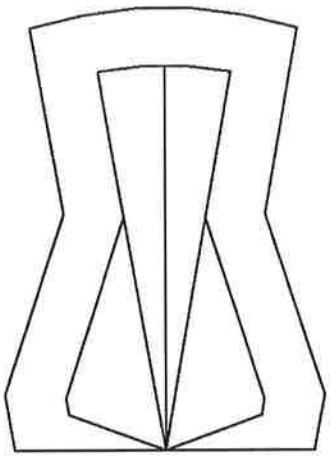
.50 Cal M2 Ball

Scale: 1:50,000
Distance X: 6,500m
Impact Media: worst case
Vertical Hazard: 904m

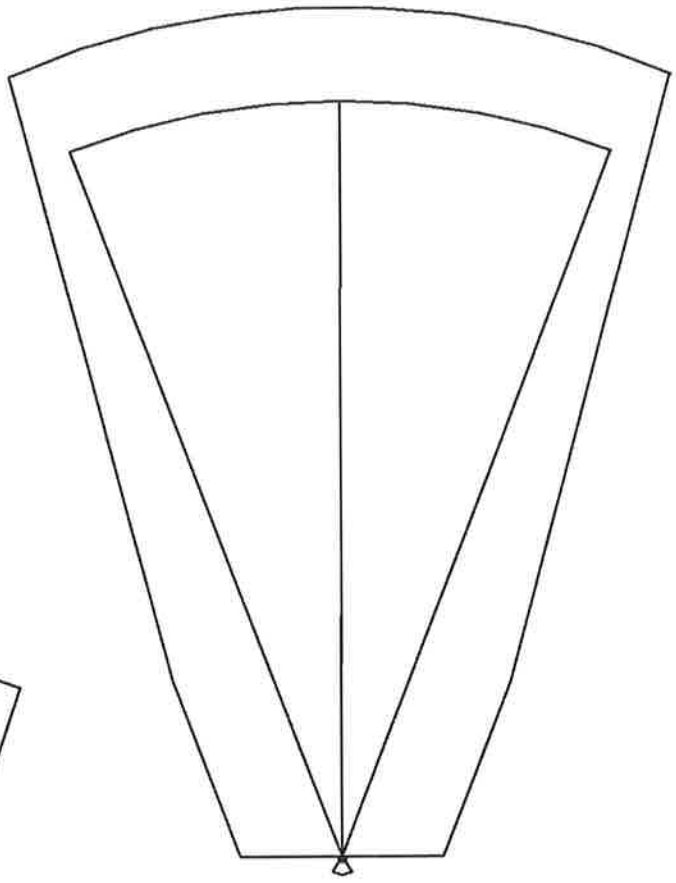


7.62mm Special Ball M118

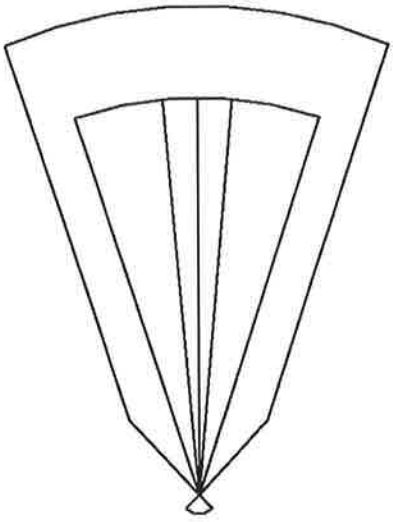
Scale:	1:50,000
Distance X:	5,288m
Impact Media:	worst case
Vertical Hazard:	752m



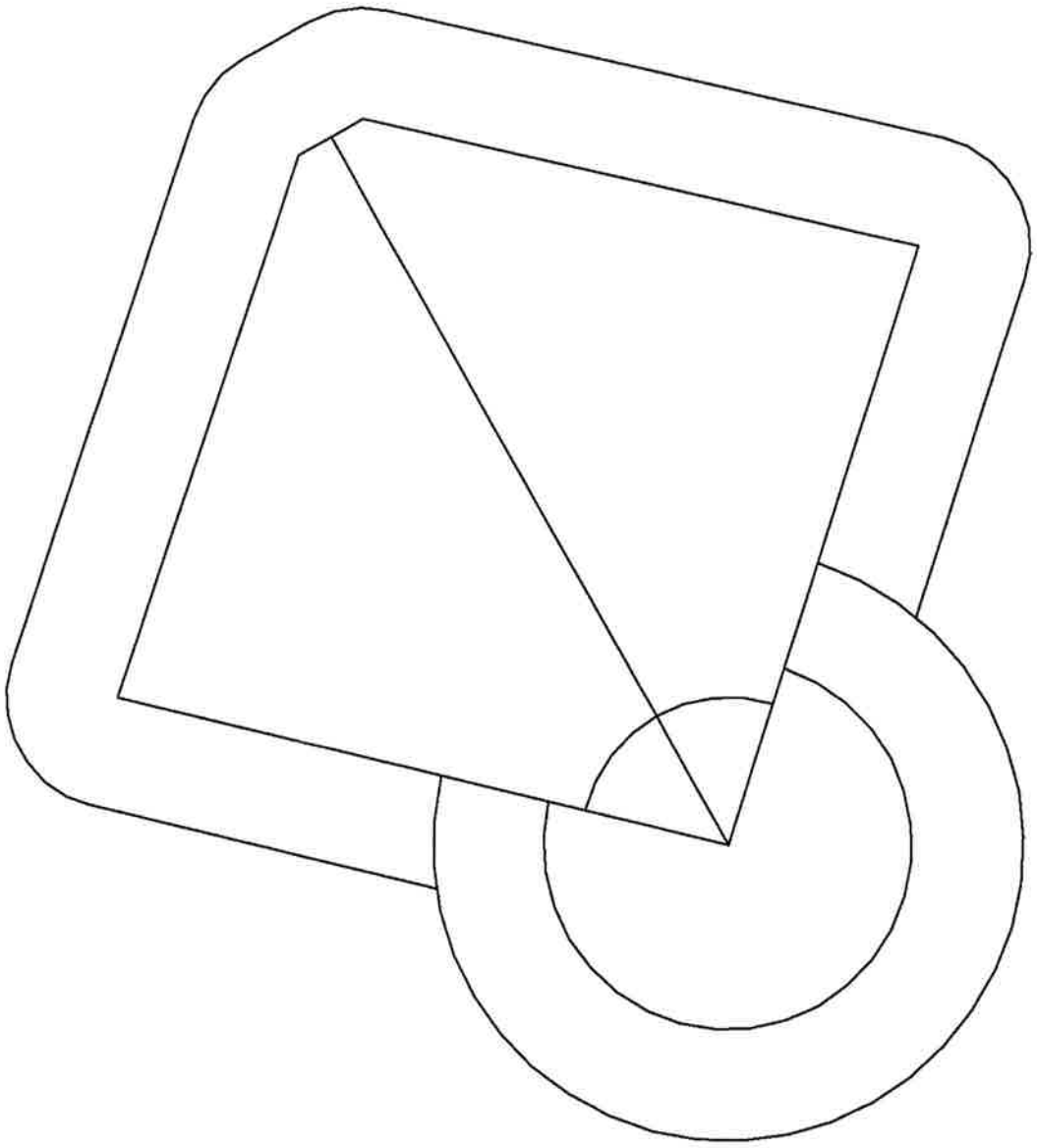
40mm MK19 Mod 3
M430 HEDP
Scale: 1:50,000
Distance X: 2,037m
Impact Media: worst case



Javelin HE Warhead
Scale: 1:50,000
Distance X: 4,0000m
Impact Media: worst case
5° launcher angle



AT4 84mm HEAT
Scale: 1:50,000
Distance X: 2,100m
Impact Media: worst case
5° rocket angle



TOW 2BH HE Warhead
Scale: 1:50,000
Distance X: 4,400m
Impact Media: worst case
5° Launcher Angle

Appendix C

PROPAGATION ANALYSIS

PROPIGATION ANALYSIS
HS-1 THRU HS-17
(BASE LINE NOISE IMPACT / NO MITIGATION)

Notes:
1. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
2. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	247	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	6387	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	6391.8	
c =	6387.1	
δ = a+b-c =	287.7	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	78.0	33.0	28	49.5	10	68.0	68.1
125	155	0.10	77.6	65.4	31	46.0	15	62.6	62.7
250	155	0.31	76.2	130.8	34	41.6	20	56.2	56.4
500	155	0.75	73.4	261.5	37	35.6	25	48.4	48.6
1000	155	1.34	69.6	523.0	40	28.7	30	39.6	40.0
2000	155	2.68	61.1	1046.1	43	16.7	35	26.1	26.6
4000	155	7.56	29.9	2092.2	46	-18.8	40	-10.1	-9.5
8000	155	26.40	-90.4	4184.3	49	-147.6	45	-135.4	-135.2
A-Wt	162.0		74.6			37.6		52.0	52.2

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt=	0.0

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	248	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	4864	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	4870.3	
c =	4864.1	
δ = a+b-c =	289.2	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	80.4	33.1	28	51.7	10	70.4	70.5
125	155	0.10	80.1	65.7	31	48.4	15	65.1	65.2
250	155	0.31	79.1	131.5	34	44.3	20	59.1	59.2
500	155	0.75	76.9	262.9	37	39.0	25	51.9	52.1
1000	155	1.34	74.0	525.8	40	33.0	30	44.0	44.4
2000	155	2.68	67.5	1051.6	43	23.0	35	32.5	33.0
4000	155	7.56	43.8	2103.2	46	-5.1	40	3.8	4.3
8000	155	26.40	-47.9	4206.4	49	-105.2	45	-92.9	-92.6
A-Wt	162.0		78.5			40.7		55.0	55.2

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= 0.0

Notes:
1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet	
H_{source} =	283
$H_{receiver}$ =	267
$H_{barrier}$ =	0
H_{LOS}	283.0
$D_{receiver-srce}$ =	4437
$D_{barrier-srce}$ =	0
a =	283.0
b =	4445.0
c =	4437.0
δ = a+b-c =	291.0

Elevation of the source
Elevation of the receiver
Elevation of the top of the barrier
Elevation of barrier if it just breaks the line of sight.
If your elevation of top of barrier is less than this, the IL will be zero.
Distance between receiver and source
Distance between barrier and source

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	81.2	33.3	28	52.5	10	71.2	71.3
125	155	0.10	80.9	66.1	31	49.1	15	65.9	66.0
250	155	0.31	80.0	132.3	34	45.1	20	60.0	60.1
500	155	0.75	78.0	264.5	37	40.1	25	53.0	53.2
1000	155	1.34	75.4	529.1	40	34.3	30	45.4	45.7
2000	155	2.68	69.5	1058.2	43	24.9	35	34.5	34.9
4000	155	7.56	47.8	2116.3	46	-1.2	40	7.8	8.3
8000	155	26.40	-35.8	4232.7	49	-93.3	45	-80.8	-80.5
A-Wt	162.0		79.7			41.7		56.0	56.2

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= [redacted]

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	285	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	4414	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	4423.2	
c =	4414.0	
δ = a+b-c =	292.2	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	81.3	33.5	28	52.5	10	71.3	71.3
125	155	0.10	81.0	66.4	31	49.2	15	66.0	66.1
250	155	0.31	80.0	132.8	34	45.2	20	60.0	60.2
500	155	0.75	78.1	265.6	37	40.1	25	53.1	53.3
1000	155	1.34	75.5	531.3	40	34.3	30	45.5	45.8
2000	155	2.68	69.6	1062.5	43	25.0	35	34.6	35.0
4000	155	7.56	48.0	2125.0	46	-1.0	40	8.0	8.5
8000	155	26.40	-35.1	4250.0	49	-92.7	45	-80.1	-79.9
A-Wt	162.0		79.8			41.8		56.1	56.2

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	295	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	4117	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	4127.6	
c =	4117.0	
δ = a+b-c =	293.5	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	81.9	33.6	28	53.0	10	71.9	71.9
125	155	0.10	81.6	66.7	31	49.7	15	66.6	66.7
250	155	0.31	80.7	133.4	34	45.8	20	60.7	60.9
500	155	0.75	78.9	266.9	37	40.9	25	53.9	54.1
1000	155	1.34	76.5	533.7	40	35.2	30	46.5	46.8
2000	155	2.68	71.0	1067.4	43	26.3	35	36.0	36.4
4000	155	7.56	50.9	2134.8	46	1.8	40	10.9	11.4
8000	155	26.40	-26.7	4269.6	49	-84.3	45	-71.7	-71.5
A-Wt	162.0		80.7			42.5		56.8	57.0

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	301	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	3189	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	3203.2	
c =	3189.1	
δ = a+b-c =	297.1	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	84.1	34.0	28	55.0	10	74.1	74.2
125	155	0.10	83.9	67.5	31	51.8	15	68.9	69.0
250	155	0.31	83.2	135.1	34	48.1	20	63.2	63.4
500	155	0.75	81.8	270.1	37	43.5	25	56.8	57.0
1000	155	1.34	80.0	540.2	40	38.5	30	50.0	50.3
2000	155	2.68	75.7	1080.4	43	30.8	35	40.7	41.1
4000	155	7.56	60.1	2160.9	46	10.8	40	20.1	20.6
8000	155	26.40	0.0	4321.8	49	-57.9	45	-45.0	-44.7
A-Wt	162.0		84.1			45.2		59.5	59.6

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:
1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	292	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2490	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2507.1	
c =	2490.0	
δ = a+b-c =	300.0	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	86.3	34.4	28	57.0	10	76.3	76.4
125	155	0.10	86.1	68.2	31	53.8	15	71.1	71.2
250	155	0.31	85.6	136.4	34	50.2	20	65.6	65.7
500	155	0.75	84.5	272.8	37	46.0	25	59.5	59.7
1000	155	1.34	83.0	545.5	40	41.3	30	53.0	53.3
2000	155	2.68	79.7	1091.1	43	34.5	35	44.7	45.1
4000	155	7.56	67.6	2182.2	46	17.9	40	27.6	28.0
8000	155	26.40	20.6	4364.3	49	-37.7	45	-24.4	-24.2
A-Wt	162.0		87.2			47.6		62.0	62.2

Delta A-wt=	0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:
1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	307	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier If it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2553	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2571.4	
c =	2553.1	
δ = a+b-c =	301.3	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	86.1	34.5	28	56.7	10	76.1	76.1
125	155	0.10	85.9	68.5	31	53.6	15	70.9	71.0
250	155	0.31	85.4	136.9	34	50.0	20	65.4	65.5
500	155	0.75	84.2	273.9	37	45.7	25	59.2	59.4
1000	155	1.34	82.7	547.8	40	41.0	30	52.7	53.0
2000	155	2.68	79.3	1095.6	43	34.2	35	44.3	44.7
4000	155	7.56	66.9	2191.1	46	17.2	40	26.9	27.3
8000	155	26.40	18.8	4382.2	49	-39.6	45	-26.2	-26.0
A-Wt	162.0		86.9			47.3		61.8	61.9

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= 0

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	298	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	1890	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	1913.3	
c =	1890.1	
δ = a+b-c =	306.3	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	88.7	35.1	28	59.0	10	78.7	78.8
125	155	0.10	88.6	69.6	31	55.8	15	73.6	73.7
250	155	0.31	88.2	139.2	34	52.4	20	68.2	68.3
500	155	0.75	87.4	278.4	37	48.4	25	62.4	62.5
1000	155	1.34	86.2	556.9	40	44.1	30	56.2	56.5
2000	155	2.68	83.7	1113.8	43	38.1	35	48.7	49.1
4000	155	7.56	74.5	2227.6	46	24.4	40	34.5	34.9
8000	155	26.40	38.9	4455.1	49	-20.0	45	-6.1	-6.0
A-Wt	162.0		90.6			50.1		64.8	64.9

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:
1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	300	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver\text{-}srce}$ =	2019	Distance between receiver and source
$D_{barrier\text{-}srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2041.2	
c =	2019.1	
δ = a+b-c =	305.1	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	88.1	34.9	28	58.5	10	78.1	78.2
125	155	0.10	88.0	69.3	31	55.4	15	73.0	73.1
250	155	0.31	87.6	138.7	34	51.9	20	67.6	67.7
500	155	0.75	86.7	277.4	37	47.8	25	61.7	61.9
1000	155	1.34	85.5	554.7	40	43.4	30	55.5	55.8
2000	155	2.68	82.8	1109.4	43	37.3	35	47.8	48.2
4000	155	7.56	72.9	2218.9	46	23.0	40	32.9	33.3
8000	155	26.40	34.9	4437.7	49	-23.8	45	-10.1	-9.9
A-Wt	162.0		89.8			49.5		64.1	64.3

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	282	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2150	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2168.4	
c =	2150.0	
δ = a+b-c =	301.4	

f(Hz)	L_w (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	87.6	34.5	28	58.1	10	77.6	77.6
125	155	0.10	87.4	68.5	31	54.9	15	72.4	72.5
250	155	0.31	87.0	137.0	34	51.4	20	67.0	67.1
500	155	0.75	86.0	274.0	37	47.3	25	61.0	61.2
1000	155	1.34	84.8	548.0	40	42.9	30	54.8	55.0
2000	155	2.68	81.9	1096.1	43	36.6	35	46.9	47.3
4000	155	7.56	71.4	2192.1	46	21.6	40	31.4	31.8
8000	155	26.40	30.9	4384.2	49	-27.6	45	-14.1	-13.9
A-Wt	162.0		89.0			49.0		63.5	63.6

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet	
H_{source} = 283	Elevation of the source
$H_{receiver}$ = 235	Elevation of the receiver
$H_{barrier}$ = 0	Elevation of the top of the barrier
H_{LOS} 283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ = 2938	Distance between receiver and source
$D_{barrier-srce}$ = 0	Distance between barrier and source
a = 283.0	
b = 2947.4	
c = 2938.4	
δ = a+b-c = 292.0	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	84.8	33.4	28	55.8	10	74.8	74.9
125	155	0.10	84.6	66.4	31	52.6	15	69.6	69.7
250	155	0.31	84.0	132.7	34	48.9	20	64.0	64.2
500	155	0.75	82.7	265.4	37	44.5	25	57.7	57.9
1000	155	1.34	81.0	530.9	40	39.6	30	51.0	51.3
2000	155	2.68	77.1	1061.8	43	32.2	35	42.1	42.5
4000	155	7.56	62.7	2123.6	46	13.4	40	22.7	23.2
8000	155	26.40	7.4	4247.1	49	-50.4	45	-37.6	-37.4
A-Wt	162.0		85.2			46.1		60.3	60.5

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	235	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2331	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2342.8	
c =	2331.5	
δ = a+b-c =	294.3	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	86.9	33.7	28	57.6	10	76.9	76.9
125	155	0.10	86.7	66.9	31	54.4	15	71.7	71.8
250	155	0.31	86.2	133.8	34	50.9	20	66.2	66.3
500	155	0.75	85.2	267.6	37	46.7	25	60.2	60.4
1000	155	1.34	83.8	535.1	40	42.1	30	53.8	54.1
2000	155	2.68	80.7	1070.3	43	35.6	35	45.7	46.1
4000	155	7.56	69.3	2140.5	46	19.8	40	29.3	29.8
8000	155	26.40	25.4	4281.0	49	-32.7	45	-19.6	-19.4
A-Wt	162.0		88.0			48.4		62.7	62.8

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= 0.0

Notes:
1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (I.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	229	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	4235	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	4241.2	
c =	4235.3	
δ = a+b-c =	288.8	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	81.6	33.1	28	52.9	10	71.6	71.7
125	155	0.10	81.3	65.6	31	49.6	15	66.3	66.4
250	155	0.31	80.4	131.3	34	45.6	20	60.4	60.6
500	155	0.75	78.6	262.6	37	40.6	25	53.6	53.8
1000	155	1.34	76.1	525.2	40	34.9	30	46.1	46.4
2000	155	2.68	70.4	1050.3	43	25.9	35	35.4	35.9
4000	155	7.56	49.7	2100.7	46	0.8	40	9.7	10.3
8000	155	26.40	-30.1	4201.3	49	-87.5	45	-75.1	-74.8
A-Wt	162.0		80.4			42.3		56.5	56.7

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= [0]C

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	283	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2818	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2832.2	
c =	2818.0	
δ = a+b-c =	297.2	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	85.2	34.0	28	56.0	10	75.2	75.3
125	155	0.10	85.0	67.5	31	52.8	15	70.0	70.1
250	155	0.31	84.4	135.1	34	49.2	20	64.4	64.6
500	155	0.75	83.2	270.2	37	44.8	25	58.2	58.4
1000	155	1.34	81.5	540.3	40	39.9	30	51.5	51.8
2000	155	2.68	77.7	1080.6	43	32.8	35	42.7	43.2
4000	155	7.56	64.0	2161.3	46	14.6	40	24.0	24.5
8000	155	26.40	10.9	4322.5	49	-47.1	45	-34.1	-33.9
A-Wt	162.0		85.7			46.4		60.8	60.9

* p = 1.00 atm
T = 59° F
h = 70 %

Delta A-wt= 0.0

Notes:

1. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
2. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
3. Ground effects have been neglected. They can be significant at times.
4. Enter information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	268	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight. If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	2945	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	2957.2	
c =	2945.0	
δ = a+b-c =	295.1	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	84.8	33.8	28	55.7	10	74.8	74.9
125	155	0.10	84.6	67.1	31	52.5	15	69.6	69.7
250	155	0.31	84.0	134.2	34	48.8	20	64.0	64.1
500	155	0.75	82.7	268.3	37	44.4	25	57.7	57.9
1000	155	1.34	81.0	536.6	40	39.5	30	51.0	51.3
2000	155	2.68	77.0	1073.2	43	32.1	35	42.0	42.4
4000	155	7.56	62.7	2146.4	46	13.3	40	22.7	23.1
8000	155	26.40	7.2	4292.8	49	-50.8	45	-37.8	-37.6
A-Wt	162.0		85.1			46.0		60.3	60.5

Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Notes:

1. Use this spreadsheet only for omnidirectional / tri-directional point sources (i.e., they have spherical divergence)
2. This spreadsheet is only accurate for distances where high wind and temperature gradients are not a factor.
3. Ground effects have been neglected. They can be signlficant at times.
4. Enter Information only in the yellow cells.
5. This worksheet only works if the barrier breaks the line of sight between the listener and noise source. Verify that $H_{barrier}$ is greater than H_{LOS}.
6. The answer is the Delta A-wt at the bottom in the pink cell.

Geometry in feet		
H_{source} =	283	Elevation of the source
$H_{receiver}$ =	250	Elevation of the receiver
$H_{barrier}$ =	0	Elevation of the top of the barrier
H_{LOS}	283.0	Elevation of barrier if it just breaks the line of sight.
		If your elevation of top of barrier is less than this, the IL will be zero.
$D_{receiver-srce}$ =	4159	Distance between receiver and source
$D_{barrier-srce}$ =	0	Distance between barrier and source
a =	283.0	
b =	4166.5	
c =	4159.1	
δ = a+b-c =	290.4	

f(Hz)	L_W (dB re 1 pW)	Air Absorption (dB/1000 ft)*	L_p at $D_{receiver}$ w/o Barrier (db re 1μPa)	Fresnel Number, N	$IL_{barrier}$ (dB)	L_p at $D_{receiver}$ Over Barrier (dB)	TL Barrier (dB)	L_p at $D_{receiver}$ Thru Barrier (dB)	L_p at $D_{receiver}$ Total (dB)
63	155	0.03	81.8	33.3	28	53.0	**10**	71.8	71.9
125	155	0.10	81.5	66.0	31	49.7	**15**	66.5	66.6
250	155	0.31	80.6	132.0	34	45.8	**20**	60.6	60.8
500	155	0.75	78.8	264.0	37	40.8	**25**	53.8	54.0
1000	155	1.34	76.3	528.0	40	35.2	**30**	46.3	46.7
2000	155	2.68	70.8	1055.9	43	26.2	**35**	35.8	36.2
4000	155	7.56	50.5	2111.8	46	1.5	**40**	10.5	11.0
8000	155	26.40	-27.9	4223.7	49	-85.4	**45**	-72.9	-72.6
A-Wt	162.0		80.6			42.4		56.7	56.9

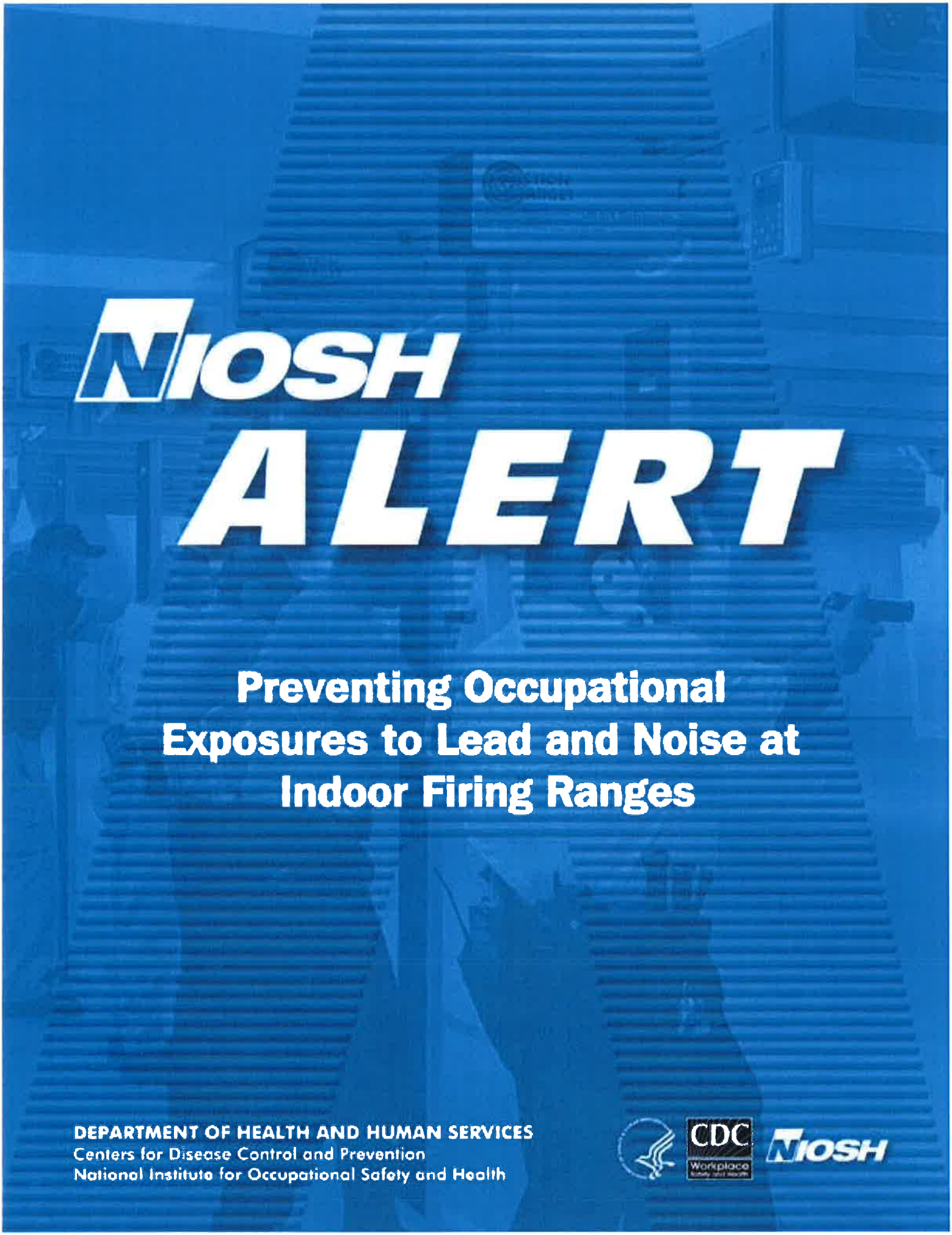
Delta A-wt= 0.0

* p = 1.00 atm
T = 59° F
h = 70 %

Appendix D

U.S. DEPARTMENT
OF
HEALTH AND HUMAN SERVICES

NIOSH ALERT



NIOSH ALERT

Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CDC Workplace Safety and Health

NIOSH

DISCLAIMER

The findings and recommendations in this document were developed by the National Institute for Occupational Safety and Health (NIOSH) in its role of conducting research and making recommendations to prevent work-related illnesses and injuries. They are designed to protect the health and safety of persons employed at firing ranges, and the health and safety of shooters who use the range in a job-related capacity, such as law enforcement officers or others for whom training in the handling of firearms is a condition or factor of employment.

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DHHS (NIOSH) Publication Number 2009–136

April 2009

SAFER • HEALTHIER • PEOPLE™

NIOSH ALERT

Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges

WARNING!

Workers at indoor firing ranges may be exposed to hazardous lead concentrations and noise levels.

Employers and firing range operators should take the following steps to protect their workers and shooters from exposure to hazardous lead concentrations and noise levels at indoor firing ranges:

1. Provide workers and shooters with information about hazards and appropriate training to prevent hazardous exposures.

- Provide general information and specific hazard warnings through workplace postings and targeted training programs.
- State the precautions and hygiene practices required of the firing range workers and shooters.
- Train workers and shooters on the actions and means available to eliminate or limit potential exposures.
- Inform workers and shooters about symptoms that may indicate a health problem. Also inform workers that elevated lead levels can occur without overt symptoms and that a blood lead level test should be done if there is concern about an exposure to lead.
- Inform pregnant workers and shooters, or those considering pregnancy, about the possible adverse health effects to the fetus.

2. Establish effective engineering and administrative controls.

- If feasible, provide workers with cleaning facilities and lockers and develop a mandatory washing and hygiene program for shooters and workers to limit personal and take-home contamination.
- Install a well-designed supply air and exhaust ventilation system.
- Maintain and replace air filters regularly.
- Design and maintain the firing range structure to limit the transmission of harmful noise levels to adjacent areas.
- Incorporate effective administrative controls in the workers' schedules to limit their exposure time and ensure safe and clean working conditions.

3. Provide workers and shooters with personal protective equipment and other protective measures.

- Provide a variety of hearing protection devices including earplugs and earmuffs.
- Provide skin protection, eye protection, and NIOSH approved respirators for workers involved in cleaning lead-contaminated surfaces and areas.
- Provide floor mats, knee pads, and shoe covers when necessary to limit transfer of lead to clothing.

4. Provide workers with health and medical monitoring.

- Provide workers with initial and periodic medical monitoring as required by the OSHA lead standard (29 CFR 1910.1025(j)).
- Best medical management practices, from organizations such as the Association of Occupational and Environmental Clinics or those provided in the journal Environmental Health Perspectives [Kosnett et al. 2007] should be recommended for all lead-exposed adults (workers and shooters).
- Provide workers with audiometric evaluations as required by OSHA noise standard (29 CFR 1910.95(d)(e)(g)(h)).

For additional information, see ***NIOSH Alert: Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges*** [DHHS (NIOSH) Publication No. 2009–136]. Single copies of the Alert are available free from the following:

1–800–CDC–INFO (1–800–232–4636)
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Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH ALERT

Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges

WARNING!

Workers at indoor firing ranges may be exposed to hazardous lead concentrations and noise levels.

Workers should take the following steps to reduce exposure to hazardous lead concentrations and noise levels at indoor firing ranges:

1. Stay informed.

- Understand the safety issues and health hazards associated with lead and noise exposures.
- Follow safe work practices identified by your employer or range operator.
- Participate in all safety training and health monitoring programs offered by your employer or range operator.

2. Protect yourself.

- Use double hearing protection (earplugs and earmuffs) whenever possible.
- Wear respirators and full protective outer clothing when performing range maintenance.
- Wear gloves and eye protection when using chemicals to clean weapons or firing range surfaces.

3. Use good work practices and personal hygiene.

- Wash hands, forearms, and face before eating, drinking, smoking, or contact with other people.
- Change clothes and shoes before leaving the firing range facilities.
- Wash clothes or uniforms used at the firing range separately from family's clothing.

4. Know and report symptoms.

- Common symptoms of lead poisoning in adults include nausea, diarrhea, vomiting, poor appetite, weight loss, anemia, excess lethargy or hyperactivity, headaches, abdominal pain, and kidney problems.
- If you suspect you may have been exposed to lead, even if you have no symptoms, ask about having a blood lead level test done.
- Exposure to high levels of noise can lead to hearing loss, tinnitus (ringing in the ear), stress, anxiety, high blood pressure, gastro-intestinal problems, and chronic fatigue.
- Report any of these symptoms to your employer or range operator.
- Seek medical attention when appropriate.

For additional information, see ***NIOSH Alert: Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges*** [DHHS (NIOSH) Publication No. 2009–136]. Single copies of the Alert are available free from the following:

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NIOSH ALERT

Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges

WARNING!

Workers at indoor firing ranges may be exposed to hazardous lead concentrations and noise levels.

The National Institute for Occupational Safety and Health (NIOSH) requests help in preventing injury and illness in workers at indoor firing ranges in the United States. Workers are potentially exposed to hazardous amounts of lead and noise at these ranges. They include thousands of employees at the firing ranges as well as more than a million Federal, State, and local law officers who train regularly at these facilities. In addition to workers, 20 million active target shooters are potentially exposed to lead and noise hazards at indoor firing ranges.

This Alert presents five case reports that document lead and noise exposures of law enforcement officers and students. The Alert examines firing range operations, exposure assessment and control methods, existing regulations, and exposure standards and guidelines.

NIOSH requests that the recommendations in this Alert be brought to the attention of all firing range owners, operators, workers, and users as well as safety and health officials, industry associations, unions, and editors of trade journals.

BACKGROUND

The Bureau of Justice Statistics estimates that 105,000 Federal law enforcement officers and more than 1 million State and local police officers are employed in the United States [DOJ 2004]. These officers are required to train regularly in the accurate and proficient use of firearms. Indoor firing ranges have gained wide appeal among law enforcement agencies because they offer protection from inclement weather conditions and can be operated around the clock under controlled environmental conditions. The National Shooting Sports Foundation estimates that there are 20 million active target shooters in the United States. Of those, 13.8 million are rifle shooters and 10.7 million participate in handgun target shooting [NSSF 2006]. NIOSH estimates that 16,000 to 18,000 firing ranges

operate in the United States. Some are operated without the benefit of sufficient environmental and occupational health controls in place to effectively protect the health of shooters and firing range personnel from the adverse effects of exposure to lead, noise, and other contaminants. The hazards from exposure to lead (airborne, ingestion, and skin), noise, and other contaminants at indoor firing ranges have been widely investigated [Valway et al. 1989; Novotny et al. 1987; Price 1989]. Some of these investigations have documented elevated blood lead levels and hearing loss—particularly among employees and instructors.

During the last 2 decades, NIOSH has performed numerous Health Hazard Evaluations (HHEs) of indoor firing ranges and documented the hazards of exposure to lead and noise among firing range operators, workers, and shooters. In 1975, NIOSH published a technical document titled *Lead Exposure and Design Considerations for Indoor Firing Ranges* to provide recommendations for reducing or eliminating hazards associated with indoor firing ranges [NIOSH 1975]. This Alert highlights the issues inherent in operating such facilities and addresses advances in exposure assessment methods, control technologies, and new regulations and exposure guidelines.

Although the scope of this Alert is specifically targeted at indoor firing ranges, overexposures to lead and noise at outdoor firing ranges have been documented in several studies [Tripathi et al. 1991; Goldberg et al. 1991; Murphy 2007]. Many of the recommendations that are outlined in this Alert can also be applied to protecting workers and shooters who use outdoor and covered firing ranges.

CURRENT REGULATIONS, RECOMMENDATIONS, AND OTHER GUIDELINES

The primary sources of exposure standards and guidelines for the U.S. workplace are the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) (29 CFR* 1910) and the NIOSH recommended exposure limits (RELs) [NIOSH 1992a]. Most employers are mandated to follow the OSHA standards; however, since current standards and regulations are based on outdated medical information, employers are encouraged to follow the most protective criteria.

OSHA Regulations

The Federal OSHA General Industry Lead Standard (29 CFR 1910.1025) establishes specific airborne lead exposure levels for employees working in areas where airborne lead is present. Lead exposure is determined through air sampling that measures the concentration of lead in the air (the number of micrograms of lead present in a cubic meter of air). The standard creates two levels of exposure, the action level and the PEL. The action level for airborne lead exposure is 30 micrograms per cubic meter ($\mu g/m^3$) of air as an 8-hour time-weighted average (TWA). If it is determined that airborne lead concentrations exceed the action level for more than 30 days per year, an employer must provide a medical surveillance program to the worker consisting of biological monitoring and medical examinations and consultations. Should a worker's average blood lead level (BLL) meet or exceed 50 micrograms of lead per deciliter (μg/dL) of blood, the employer is required to temporarily remove

Code of Federal Regulations. See CFR in references.

the worker from the work area. The OSHA standard does provide for economic protection for such medically removed workers. Medically removed workers cannot return to jobs involving lead exposure until their BLLs are below 40 μg/dL. Benefits must be provided during the period of temporary medical removal—i.e., the employee continues to receive the same earnings, seniority, and other rights and benefits he or she would have had if they had not been removed. The OSHA PEL for airborne exposure to lead is 50 $\mu g/m^3$ as an 8-hour TWA. The PEL is reduced for shifts greater than 8 hours using the formula:

maximum PEL in $\mu g/m^3$ = 400 / hours worked per day

If airborne lead levels exceed the PEL for more than 30 days per year, then an employer is required to implement additional monitoring and management activities.

Currently, 24 States and 2 territories administer and enforce their own occupational safety and health programs. A list of these "State Plan States" can be obtained by contacting the appropriate authority in the State where the firing range is operated or through the OSHA Web site at *www.osha.gov*. It is important to note that State Plans must be at least as protective as the Federal OSHA standards.

For noise exposure, the Federal OSHA standard for occupational noise exposure (29 CFR 1910.95) specifies a maximum PEL of 90 decibels, A-weighted (dBA), averaged over an 8-hour time period. Noise generated from weapons is classified as impulse noise. The OSHA standard states that exposure to impulse noise should not exceed 140 decibels (dB) sound pressure level (SPL). The regulation uses a 5-dB exchange rate. This means that when the noise level is increased by 5 dBA, the amount of time a person can be exposed is cut in half. For example, a person who is exposed to noise levels of 95 dBA can be exposed to only 4 hours in order to be within the daily OSHA PEL. The OSHA standard has an action level of 85 dBA, which stipulates that an employer shall administer a continuing, effective hearing conservation program when the 8-hour TWA equals or exceeds the action level. The program must include exposure monitoring, employee notification, observation, an audiometric testing program, hearing protection, training programs, and maintenance of records. The standard also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dBA (8-hour TWA), feasible engineering or administrative controls shall be implemented to reduce workers' exposure levels.

NIOSH Recommendations

The NIOSH REL for airborne lead is 50 $\mu g/m^3$ as an 8-hr TWA; airborne concentrations should be maintained so that a worker's BLL remains below 60 μg lead/100 g of whole blood [NIOSH 1992a].

In addition to inhalation exposures, lead from contaminated surfaces and from firearms discharge can be transferred to people's skin, especially the hands. Lead-contaminated hands can contribute to ingestion while handling food, beverages, and other items that contact the mouth. Skin exposures often result from hidden hazards that are not anticipated or recognized, and hence are inadequately controlled. Controlling lead-contaminated surfaces (and skin contamination) is highly dependent on anticipation and identification of lead contamination on surfaces; strict attention and

adherence to personal hygiene practices; and appropriate administrative controls (e.g., hazard communication). Currently, there are no Federal occupational exposure limits for lead contamination of surfaces. However, NIOSH researchers have investigated surface and skin contamination from lead in a variety of occupational settings and developed two analytical methods for identifying lead contamination. NIOSH Method 9100 is a surface-wipe collection method that can be used to quantitatively determine surface lead concentrations to a detection limit of 0.1 μg per sample. Method 9105 is an instant qualitative wipe method that was initially designed to detect the presence of lead on workers' skin with a limit of identification of 15 μg per sample. The method is commercially available under the brand name *Full Disclosure for Lead (US Patent 6,248,593)* and can be used for identifying the presence of lead contamination on environmental surfaces [NIOSH 1994]. Both methods are practical and appropriate for identifying workplace surface lead contamination and evaluating the effectiveness of skin and surface decontamination for the purpose of reducing exposure risks. Both methods will detect the presence of lead contamination and lead from residues emitted from firearms usage.

NIOSH research shows that washing hands with soap and water is not completely effective in removing lead (and other toxic metals) from the surface of the skin [NIOSH 1992b; NIOSH 1996; NIOSH 1999]. To remove lead from skin, NIOSH researchers recently developed a novel and highly effective skin decontamination/cleansing method [Esswein and Boeniger 2005].

Regarding noise, the NIOSH REL for noise (8-hour TWA) is 85 dBA using a 3-dB exchange rate (see OSHA regulations in previous section for an explanation of exchange rates). NIOSH also recommends that no exposure be allowed above 140 dB SPL [NIOSH 1998].

Other Guidelines and Best Management Practices

In addition to the standards and guidelines identified above, U.S. government agencies (including the Department of Defense), the firearm industry, and shooting-sports organizations have created guidance documents and best management practices for firing ranges. Furthermore, the U.S. government and several professional organizations have general guidance documents concerning occupational exposure to lead and noise.

U.S. Government Agencies/Military Industrial Hygiene Standards and Guidelines for Firing Ranges

The U.S. Department of Justice (DOJ), Immigration and Naturalization Service[†] published a document titled *INS/NFU Firing Range Design Standard,* which focuses on necessary considerations for both indoor and outdoor firing ranges that meet the needs of DOJ training criteria. These considerations include lead and noise exposure controls and evaluations of environmental, occupational health, and training issues at existing firing ranges. The standard is intended as a supplemental guide to the *U.S. Border Patrol Facilities Design Guide* [DOJ 2002].

The U.S. Environmental Protection Agency (EPA) Best Management Practices at Outdoor Shooting Ranges, while targeted for outdoor ranges, provides owners and operators of outdoor firing ranges with information

[†]Immigration and Naturalization Service is now called the U.S. Citizenship and Immigration Services and is part of the U.S. Department of Homeland Security.

on lead management and recommendations for reducing lead contamination [EPA 2005].

The U.S. military operates more than 3,000 indoor firing ranges. The U.S. Navy Environmental Health Center developed a reference guide titled *Indoor Firing Ranges Industrial Hygiene Guide* to provide firing range operators, industrial hygienists, safety professionals, and technicians with guidelines and recommendations on firing range operation and maintenance [USN 2002]. In addition, the U.S. Army Corps of Engineers published *Design Manual for Indoor Firing Ranges* in 1990 to provide guidance for new design considerations, retrofitting existing indoor firing ranges, and safety and maintenance requirements for Department of Defense range facilities [USACE 1990]. Although these publications discuss numerous issues involved with firing range operation, they do not represent a comprehensive listing of the material available from government agencies and the military.

Firearm Industry Guidelines

The National Association of Shooting Ranges (NASR), a division of the National Shooting Sports Foundation (NSSF), has developed a manual titled *Lead Management and OSHA Compliance for Indoor Shooting Ranges* [NASR 2004]. This manual addresses the potential of lead exposure at firing ranges and presents methods for managing exposures as well as compliance with the OSHA lead standard 29 CFR 1910.1025. This document was developed in partnership with OSHA and NIOSH.

Shooting Sports Organizations

The National Rifle Association (NRA) manual titled *The NRA Source Book: A Guide to Planning and Construction* provides basic and advanced guidance to assist in planning, designing, constructing, and maintaining shooting range facilities [NRA 1999].

General Guidance Concerning Occupational Exposure to Lead and Noise from the U.S. Government and Professional Organizations

Department of Health and Human Services

The Department of Health and Human Services (DHHS) identified occupational lead exposure as one of the national health objectives. In its publication *Healthy People 2010*, the DHHS proposed the elimination of occupational lead exposures that result in workers having blood lead concentrations greater than 25 μg/dL, and encouraged health departments to make elevated BLLs in children and adults a notifiable condition nationwide [DHHS 2000].

American Conference of Governmental Industrial Hygienists (ACGIH)

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a threshold limit value (TLV) for lead of 50 μg/m^3 (8-hour TWA), with worker BLLs to be controlled at or below 30 μg/dL. The ACGIH has designated lead a confirmed animal carcinogen [ACGIH 2006]. The ACGIH also states that evidence suggests exposure during pregnancy to BLLs in excess of 10 μg/dL results in developmental effects such as depressed intellectual development in children [ACGIH 2001].

The ACGIH TLV for noise is 85 dBA (8-hour TWA) with a 3-dB exchange rate and 140 dB SPL as a maximum exposure limit. The ACGIH states that exposure to certain

chemicals may result in hearing loss. In settings where workers might be exposed to noise as well as organic solvents (e.g., toluene, styrene, or xylene), heavy metals (e.g., lead, manganese, or organo-tin compounds), or other compounds (e.g., n-butyl alcohol or carbon monoxide), periodic audiograms are advised and should be carefully reviewed. The ACGIH also states that evidence suggests noise exposure in excess of a C-weighted, 8-hour TWA of 115 dB or a peak exposure of C-weighted 155 dB to the abdomen of pregnant workers beyond the fifth month of pregnancy may cause hearing loss in the fetus.

Association of Occupational and Environmental Clinics

The Association of Occupational and Environmental Clinics (AOEC) has reviewed current literature concerning lead exposure and health effects [AOEC 2007]. The AOEC has determined that the evidence provided by current health effects studies calls for an update of guidance for professionals involved with medical assessment and treatment of lead-exposed workers. Among other provisions in their guidance, the AOEC has determined that current evidence supports the need for: 1) qualitative assessment of the need for inclusion in a medical surveillance program for lead workers in addition to inclusion in a medical surveillance program based on documentation of exposure to airborne lead at a concentration above the OSHA action level; 2) increased frequency of BLL testing; 3) removal from exposure to lead for workers with BLL of 30 μg/dL or more; and 4) education of workers concerning occupational exposure to lead and provision of necessary personal protective equipment and administrative measures to prevent both occupational and take-home exposure to lead.

Environmental Health Perspectives Mini-Monograph

The March 2007 edition of Environmental Health Perspectives included a Mini-Monograph on adult lead exposure. Recommendations in this document include the following: 1) medical surveillance for all lead-exposed workers should include quarterly BLL testing for individuals with blood lead concentrations between 10 and 19 μg/dL, and semiannual testing when sustained blood lead concentrations are < 10 μg/dL; 2) pregnant women should avoid occupational or avocational lead exposure that would result in blood lead concentrations > 5 μg/dL; 3) removal from exposure to lead for workers with BLL of 30 μg/dL or more or if a worker has a sustained BLL above 20 μg/dL; and 4) annual education of lead workers concerning occupational exposure to, and control of, lead hazards as well as ongoing access to health counseling regarding lead-related health risks to prevent both occupational and take-home exposure to lead [EHP 2007].

CASE REPORTS

Many studies have shown health risks to workers from lead and noise exposures at firing ranges. The five case reports presented here describe the causes of these exposures and methods for controlling them.

Case 1—Lead exposures of law enforcement trainees

Seventeen law enforcement trainees were studied for 3 months during firearms instruction at an indoor firing range to determine their risk from lead exposure [Valway et al. 1989]. BLLs were measured before training began and every 4 weeks during the

training. Airborne lead concentrations were measured three times during the instruction period. BLLs rose from a pre-training mean of 6.5 to 50.4 μg/dL post training. Mean airborne lead concentrations were greater than 2,000 μg/m³, more than 40 times the OSHA PEL of 50 μg/m³. During the study, two changes were made to the ventilation system. The first corrected the positive pressure inside the range that had allowed lead-contaminated air to flow from the range into other parts of the building whenever the range door was opened. The second change consisted of placing fins on the air supply grille to cause smoother air flow across the firing line and to decrease air turbulence. The adjustments resulted in a large decrease of airborne lead concentrations, depending on booth location. Airborne lead concentrations dropped to below detectable levels in the control room and classroom after the first adjustment. Airborne lead concentrations were reduced substantially (94% to 97%) by using ammunition that had nylon-coated and copper-jacketed bullets.

Case 2—Lead exposures of school rifle teams

The Alaska Environmental Public Health Program initiated a statewide review of school-sponsored rifle teams after a team coach was found to have an elevated BLL of 44 μg/dL [State of Alaska 2003]. The review initially examined six rifle teams using three indoor firing ranges. Thirty-six students and 35 adults (including family members and 6 coaches) participated in the blood lead

Figure 1. A law enforcement agency five-booth indoor firing range.

testing. Two teams used a firing range that observed a regularly scheduled cleaning procedure and had a written protocol for maintenance and lead concentration monitoring. The geometric mean BLL measurements for those two teams were not elevated (1.3 μg/dL and 3.9 μg/dL, respectively).

One team used a firing range-multi-use area that for 11 years had not been evaluated for lead. The student shooters showed small but measurable lead exposure with a geometric mean of 8.1 μg/dL.

The other three teams used a firing range that was later documented to have extensive lead contamination. The teams showed elevated blood levels with geometric means of 27.9 μg/dL, 12.0 μg/dL, and 12.2 μg/dL respectively. The coaches of the 3 teams had BLLs with a geometric mean of 12.4 μg/dL; the highest level was 31 μg/dL, which is above the level considered elevated (≥ 25 μg/dL) for adults. That firing range was voluntarily closed and arrangements were made for a thorough environmental evaluation.

Case 3—Lead exposures of police officers

A NIOSH Health Hazard Evaluation [NIOSH 1997] was conducted in a five-booth indoor firing range to examine potential exposure to lead among 30 police officers who used the firing range for training and firearms qualification (Figure 1). The firing range, which was located in a police department building, was used by other area police departments as well. The firing range ventilation system was independent of the rest of the building, but most of the firing range's exhaust air was recirculated through 90% to 95% efficient filters before being directed back into the firing range. Users cleaned the firing range by dry sweeping and collecting shell casings from the floor by hand. The bullet trap was cleaned every 2–3 years. Average airborne lead concentrations were 144 $\mu g/m^3$ and 230 $\mu g/m^3$ on 2 separate survey dates. Area airborne lead samples detected lead in the control room, in a hallway outside the firing range, and at the rooftop air handling unit. Inspection of the HVAC system on the first survey found several filters missing, but were in place during the second survey. NIOSH found that the firing range was under positive pressure, with the smell of gun smoke noticeable immediately when firing started on the firing range. The measurements of supply air and exhaust air-flow rates were much lower than designed and yielded an average air velocity of 25 feet per minute (fpm) or 0.127 meters per second (m/s) at the firing line. Pressure gauges on the HVAC system did not appear to be working properly. Smoke tests revealed backflow patterns even when no one was standing at the firing line. NIOSH recommended changes in the ventilation system, a standard operating procedure for maintenance, improved clean-up and personal hygiene practices, a written respiratory protection program, ammunition substitution, and BLL monitoring.

Case 4—Lead, *take-home* lead, and noise exposures of Federal law enforcement students

NIOSH and the National Center for Environmental Health (NCEH) participated in a series of collaborative evaluations of indoor and outdoor firing ranges and related facilities at the FBI Firearms Training Unit (FTU) [NIOSH 1991]. FTU facilities consisted of an indoor training range with 23 shooting booths, a one-booth firearms testing range, and seven outdoor training ranges. The evaluations included lead and noise exposures during firearms training among firing range

Figure 2. Noise and lead exposure assessment of law enforcement officers at a 20-lane indoor firing range.

technicians, gunsmiths, and firing range instructors. The evaluations also included the potential for take-home lead contamination of workers' vehicles and homes, and for exposure of their families.

Sixteen full-time firearms instructors spent approximately 30 hours per week on the firing ranges. Sixty-one personal breathing zone samples and 30 area samples were collected to measure airborne lead. Airborne lead concentrations ranged up to 51.7 $\mu g/m^3$ for the instructors, 2.7 $\mu g/m^3$ for firing range technicians, and 4.5 $\mu g/m^3$ for gunsmiths. Short-term exposures while the custodians cleaned the firing range were as high as 220 $\mu g/m^3$. Results of carpet dust sampling collected in 14 dormitory rooms used by FBI students and 14 rooms used by non-students showed that significantly higher lead concentrations were found in the students' rooms (means of 214 $\mu g/g$ and 65 $\mu g/g$ respectively). The presence of lead in carpet samples suggests that FBI students unknowingly contaminated their living quarters with lead residues brought back to their quarters from the firing range.

The baseline and the most recent audiometric testing results were available for 14 of the 16 FBI instructors. Evaluations of the audiograms revealed that 9 of the 14 instructors (64%) had hearing losses that met the OSHA standard threshold shift criterion (i.e., changes relative to baseline of 10 decibels or more in the average hearing level at 2000, 3000, and 4000 Hz). Audiometric testing results were only available for one of the six firing range technicians, and this worker's results also met the OSHA standard threshold shift criterion. No audiometric testing results were available for the gunsmiths.

NIOSH recommended modifications to the indoor firing range ventilation system,

improved personal hygiene practices, ammunition substitution, using double hearing protection devices, establishing a hearing conservation program for workers exposed to gunfire, and continued BLL monitoring.

Case 5—Noise exposures of Federal and local law enforcement officers

NIOSH investigators conducted live-fire noise exposure evaluations [Kardous et al. 2003; NIOSH 2003; Murphy 2007] of Federal and local law enforcement officers at indoor and outdoor firing ranges to characterize salient acoustic parameters associated with weapons noise and to provide guidelines for safe exposure (Figure 3). Measurements were conducted on a representative cross section of law enforcement firearms (the Beretta .40-caliber pistol, Remington 12-gauge shotgun, and Bushmaster M4 .223-caliber assault rifle). Indoor and outdoor measurements were also obtained for the Smith and Wesson .357-caliber revolver, the Colt .45-caliber and 9-mm pistols, the Glock .40-caliber pistol, the Heckler & Koch H&K 53 and H&K 36 assault rifles, and Colt AR15 .223-caliber rifles. Measurements were conducted using a ¼-inch Bruel & Kjaer model 4136 microphone, digital audio tape recorders with a 48 kHz sampling rate or were acquired directly to a computer laptop using 96 kHz data acquisition board. Analyses on the digitized waveforms were conducted using software tools built in Matlab. Peak sound pressure levels ranged from 155–168 dB SPL. Figure 4 shows the peak sound pressure levels generated from various weapons at an indoor firing ranges. A-weighted, equivalent (averaged) levels ranged from 124–128 dBA. Hearing protectors were

Figure 3. Emissions from the discharge of firearms.

evaluated using the *Institut de Saint-Louis* (ISL) artificial head mannequin built specifically for measuring impact and impulse noise. Earmuffs with safety glasses had a peak reduction of 18 dB. The mean peak reduction for earmuffs was 26 dB, while earplugs alone provided a mean peak reduction of 24 dB. The mean peak reduction for the combined earmuff and earplugs was 44 dB.

NIOSH recommended several noise abatement strategies and modifications to the firing range structure to reduce the transmission of airborne and structural borne sounds; the use of double-hearing protection to ensure maximum protection against impulsive noise, improper fitting and other incompatibility with other protective equipment; and the establishment of a hearing conservation program.

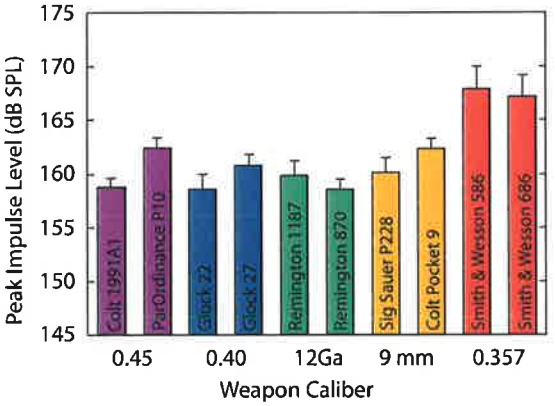

Figure 4. Peak noise levels from various small firearms.

CONCLUSIONS

The case reports described in this Alert suggest that employers, workers, and the general public may have an increased likelihood of exposure to lead through inhalation, skin contamination, and ingestion, and therefore the increased risks associated with the potential toxic health effects from lead. Numerous factors and routes of exposure can contribute to workers' and patrons' exposures to lead. Environmental factors include the type of ventilation system used at the firing range, the types of ammunition used, and the length of time that shooting occurs. Exposure risk factors include the type and frequency of work practices conducted at the range, particularly those involving cleaning the firing range and other maintenance activities.

As demonstrated by the case studies, proper ventilation, good housekeeping practices, and basic personal hygiene practices will limit or eliminate the risk of lead exposure.

In addition to lead exposure, the discharge of firearms produces peak noise levels that exceed the occupational health limits of 140 dB SPL. The case studies illustrate the need to assess impulse noise exposure correctly by using proper sound measuring instruments and techniques, and the importance of using double hearing protection while shooting as part of an overall hearing conservation program.

Potential health problems from exposure to lead and noise can be reduced or prevented by following the recommendations outlined in this Alert.

RECOMMENDATIONS

Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, NIOSH uses a hierarchy of controls as a means of determining how to implement feasible and effective solutions to reduce or eliminate workplace hazards. One representation of this hierarchy can be summarized as follows:

- Elimination or substitution

- Engineering controls
- Administrative controls
- Personal protective equipment

Control methods high on the list above are potentially more effective and protective than those appearing lower. Following the hierarchy normally leads to the implementation of inherently safer systems that substantially reduce the risk of illness or injury. The *elimination and substitution* control methods are most effective at reducing hazards, but they are also the most difficult to implement within an existing process. If the process is still at the design or development stage, elimination and substitution of hazards might be inexpensive and simple to implement. *Engineering controls* are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and are typically independent of worker interactions. *Administrative controls* and *personal protective equipment* are frequently used with existing processes where hazards are not particularly well controlled.

In addition to the previous control methods, employer and worker education and training are an essential part of any comprehensive management program.

Pursuant to OSHA's lead standard, worker exposure monitoring is covered under 29 CFR 1910.1025(d), and the medical surveillance provisions of the standard are covered at 29 CFR_1910.1025(j). Medical removal protection is covered in paragraph (k).

Controlling lead and noise hazards at indoor firing ranges may present unique and different challenges depending on several factors. These include appropriate design, construction, and maintenance of the range, appropriate and engineered ventilation systems, proper management, adequate and proper housekeeping and personal hygiene practices to limit exposures to lead.

Ammunition substitution

The substitution of less-toxic materials in the workplace is a primary preventive measure in occupational health. The primary sources of lead exposure at indoor firing ranges are lead bullets and cartridge primers. Lead fumes and dust are emitted from the exposed base of an unjacketed bullet due to contact with hot propellant gases and the physical effects of heat and friction acting on the bearing surface of an unjacketed bullet passing through the bore at high velocity. The use of jacketed (both base and bearing surface) or non-lead bullets are shown to reduce lead emissions at the firing range by as much as 80%.

It is important to note that product substitution is not necessarily an effective solution for indoor firing ranges due to certain training restrictions and operational requirements. Issues such as differences in trajectory, unknown reliability, increased cost of non-lead primers and bullets, and increased barrel wear can play a major role in determining whether substitution is a viable solution. Further, mixing spent lead bullets with metals from non-lead alternatives may render the material unfit for recycling and therefore require costly and otherwise unnecessary disposal of the spent ammunition as a hazardous waste.

Firing range operators should consider the following recommendations when assessing ammunition substitution:

- Use non-lead primers designed specifically for firing ranges. Cartridges already loaded with non-lead primers are commercially available for the most popular calibers.
- Jacketed or non-lead bullets should be used to help reduce lead exposure [NIOSH 1986; NIOSH 1995].[‡] When selecting copper-jacketed bullets, the firing range operator should ensure that the jacket covers the base and the bearing surface of the bullet. Some "full-metal jacket" bullets (sometimes called "ball ammunition") have a lead-exposed base that is not visible in a loaded cartridge. This type of bullet emits lead fume due to contact with hot propellant gases. Also, some companies manufacture half jacketed bullets that have a lead-exposed bearing surface. These bullets emit lead particles from the mechanical effects of passing through the bore. It is important to note that while some jacketed bullets present no airborne lead hazard, at the firing line, impact with the bullet trap may generate lead dust at the trap. This lead dust may present a source of lead exposure to workers performing range maintenance, cleaning of traps, and removing and disposing of spent bullets.
- Use jacketed lead bullets (as opposed to dip-coated copper plating) to minimize lead exposure in firing ranges. Most commercially available copper coatings are generally too thin or too soft to effectively isolate lead from the firing process.
- Zinc bullets should not be used without a careful assessment of safety hazards caused by their propensity to "bounce back" from the bullet traps in some firing ranges. Also, firing range operators should consider the potential for zinc bullets to damage concrete and steel surfaces in firing ranges. Operators might instead consider using frangible ammunition which can be be ideal for use with steel outdoor targets or portable "shoot houses."
- Firing range operators who depend on using lead substitutes for reducing lead exposure should ensure that firing ranges and firearms previously used with lead ammunition are appropriately cleaned and evaluated before being used in the firing range.
- Electronic simulation systems using guns equipped with lasers can provide an alternative solution for training new recruits in effective gun handling and marksmanship without using live ammunition.

[‡]NIOSH examined potential hazardous exposure to copper and zinc oxide ammunition substitutes and found levels to be far below the OSHA PEL.

Engineering controls

Ventilation is the most important engineering control for protection against primary lead exposure in indoor firing ranges (Figure 3). Well-designed supply air and exhaust ventilation systems have been shown to control exposures to lead fumes and dust in firing ranges [NASR 2004]. Monitoring and control systems that ensure proper operation of ventilation systems are also important parts of this engineering control. These systems check the operating parameters of the ventilation systems, alert firing range operators, and prevent use of the firing range when systems are not operating within specifications. When automatic control systems are not used to monitor the effective operation of the ventilation systems, OSHA requires that measurements that demonstrate the effectiveness of the systems in controlling exposure, such as capture velocity, duct velocity, or static pressure be made every 3 months. In addition, measurements of

the system's effectiveness must be made within 5 days of any change in the operation of the firing range, and/or engineering control which might result in a change in employee exposure to lead.

The following recommendations are based on NIOSH research and are intended to show the range of solutions that may be implemented by firing range operators, depending on cost and availability of resources [Crouch et al. 1991].

Lead

Supply Ventilation System Recommendations:

- Ensure that supply air systems are designed to distribute air evenly across the area of the firing range, floor to ceiling and wall to wall. If the supply air is not evenly distributed, air flow at the firing line will likely contain regions of reverse flow, causing lead and other contaminants to be carried back into the shooter's breathing zone.
- Introduce supply air as far up range as possible. A perforated wall plenum has been shown to provide uniform air distribution at the firing line. Perforated radial air diffusers mounted at ceiling height have been tested and demonstrated effective in meeting established industry and regulatory airflow criteria. Diffusers that produce jets of air can create turbulence at the firing line.
- Airflow along the firing line should be no more than 75 fpm (0.381 m/s) with a minimum acceptable flow of 50 fpm (0.254 m/s) [NIOSH 1976]. If it is desired to minimize fall-out of gun emissions downrange of the firing line, downrange airflow should be maintained at a minimum of 30 fpm (0.152 m/s) and should be evenly distributed.
- There should be no obstructions (e.g., target or ammunition storage cabinets) to the airflow between the supply air inlets and the firing line so that the supply air is distributed uniformly across the width (cross-sectional area) of the firing range.

Exhaust Ventilation System Recommendations:

- The total or combined exhaust airflow for the firing range should always be greater than the total supply airflow to ensure the firing range is maintained under negative pressure, and to prevent migration of lead-contaminated air from the firing range to the surrounding environment. Exhausting slightly more air than supplied is a general recommendation for maintaining appropriate negative pressure in the firing range. If the building envelope is not sealed, negative pressure within the building can create undesirable drafts through unplanned air pathways entering through openings in the building structure. These drafts can result in back flow at the firing line, which defeats the purpose of the ventilation system. Unplanned pathways can also result in a higher mechanical operating cost (requiring additional heating or air-conditioning). The magnitude of the negative pressure should be just sufficient to produce an inflow of air at openings such as windows and doors between the firing range and adjacent areas or surrounding environment. This can easily be evaluated using a chemical smoke tube to visually evaluate pressurization at doors, windows, etc. that are slightly open to the flow of air.

- The air should be exhausted at or behind the bullet trap. Some firing ranges are designed to have multiple exhaust points downrange to maintain downrange flow and desired velocities at the firing line.
- The exhaust system should be designed to provide minimum duct air velocities of 2500–3000 fpm (12.7–15.24 m/s) (*Industrial Ventilation Manual*, 24th Edition, Table 3–2) [ACGIH 2004]. Excessively high duct velocities are unnecessary, waste energy, and may cause rapid abrasion of ductwork.
- The ventilation system that serves the range area should be completely separated from any ventilation for the rest of the building. The exhaust air from the range should not feed into air supplies for offices, meeting rooms, or other businesses.

Air Filtration Recommendations:

- All air filtration systems should be installed in a location where they can be easily serviced.
- Air exhausted from the firing range should be appropriately filtered or the area near the outside vent be managed to prevent access and lead mobility in accordance with EPA best management practices [EPA 2005]. If lead-contaminated air is released outside the building and left unmanaged, the exterior walls of the building and surrounding grounds and waterways can become contaminated. Lead released outdoors can be re-aerosolized and result in subsequent contamination of the firing range or other buildings, and present unwanted hazards to humans if the range is in a populated area.
- The minimum filtration recommended is high-efficiency particulate air (HEPA) filtration or a minimum efficiency reporting value (MERV) of 18–19. The Institute of Environmental Sciences and Technology specifies that a certified HEPA filter must capture a minimum 99.97% of contaminants at 0.3 micron in size. This filter specification is also endorsed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- All filters potentially exposed to lead-contaminated air should be equipped with side and face gaskets to eliminate filter bypass, and air passing between the filters and the filter racks. Filter racks should also be engineered and tested to ensure that leaks do not occur after installation.
- The filtration system should be located as close to the firing range as possible to minimize the distance that lead dust needs to travel in the exhaust system before it passes through the filter. Filter systems should always be located upstream of the exhaust fan to prevent contaminating the fan with lead.

Filter System Maintenance Recommendations:

- Filter end-of-service life is indicated by a high-pressure drop (more resistance to air flow) across the filter bank. Filters should be changed according to the static pressure guidelines provided by the manufacturer. Since pre-filters are the first to encounter contaminated exhaust air from the firing range, they will load fastest. Therefore, pre-filters require more frequent change-outs than HEPA-rated filters.
- Filter change-out should be performed by personnel trained in the removal and disposal of dirty filters and in lead safety. They should use appropriate personal protective equipment and environmental precautions. Loaded filters will likely contain lead in sufficient quantity to classify

the used filter as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) (40 CFR 260–279). A Toxicity Characteristics Leaching Procedure (TCLP) test will determine whether the filter is a regulated hazardous waste under the RCRA regulation. If the filter does not meet the criteria of a hazardous waste, it can be disposed of as normal solid waste. However, if the filter does have sufficient lead to be considered a hazardous waste, there are two options: first is to recycle or reuse the filter, in which case it is not considered a waste (RCRA recycling exemption 40 CFR 261.4(a)(13)) and there are no hazardous waste handling procedures required. If the filter is not recycled, and it fails the TCLP, then it must be transported and disposed of properly in accordance with Federal, State and local regulations.

Control System Recommendations:

- A warning light should be added to warn shooters and the firing range operator that a critical system has been inactivated by a safety interlock system. Modern computer-operated firing ranges can incorporate specific warning indicators in the computer programming.
- Exhaust and supply fans should be interlocked so that all fan systems operate at the same time during active range use. Air flow from the fans should be monitored and interlocked with a critical firing range operating system to disable the firing range and alert the firing range officer when the air flow from any fan is inadequate.
- Filter access doors should be interlocked with the fan system to deactivate the fans when the door is opened.
- Pressure gauges on HVAC systems should be maintained and calibrated regularly.
- The pressure drop across each filter should be monitored and checked regularly.
- Exhaust air from the firing range should not be recirculated back into the range when economically feasible. However, exhaust air may be recirculated if a real-time particle detection system is installed downstream of the filter system. It must be demonstrated that the particle detection system is sensitive enough to detect any aerosol size range and number concentration combination of lead particles that might exceed the OSHA PEL. ANSI/ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality, [ANSI/ASHRAE 2007] provides dilution ventilation guidelines for recirculating clean and breathable air in an energy-efficient manner.

Noise

Effective noise control measures are imperative to reducing noise-induced hearing loss among firing range operators, employees, and users. It is important to understand that noise control of high intensity impulse sounds might help reduce overall noise levels inside a firing range and adjacent facilities, but it has limited effect on the noise exposure of the person firing the weapon. There is no noise control that alleviates the requirement for wearing hearing protection because the primary source of noise exposure is the weapon itself. Noise control measures should be compatible with ventilation requirements and meet fire and building codes. Noise controls typically address the primary two components of noise transmission—airborne and structural-borne sounds:

- To reduce transmission of airborne sounds, no leaks can exist between the firing range and adjacent spaces. Small openings such as electrical outlets, spaces around doors, and joints at the walls,

ceiling, and floor should be sealed with insulation and/or weather stripping as needed. Ventilation ducts that provide a direct acoustic path into adjacent spaces can be fitted with acoustic absorptive materials, both to remediate vibrations in the walls of the duct and to absorb noise transmitted along the duct. Special care must be paid to the maintenance and handling of acoustic absorptive materials to prevent lead dust accumulation. The design of walls can minimize transmission of airborne sounds through combinations of gaps, absorptive materials, and different wall thicknesses.

- To reduce the transmission of structural-borne sounds and vibration, acoustical absorptive materials should be applied to walls, windows, doors, ventilation ducts, and ceilings. Use special care when applying acoustical absorptive materials to prevent them from damage or becoming dust-laden. Typical metal or wooden stud construction has wall cavities that can be filled with insulation material. Walls that separate the firing range from adjacent parts of the building should be double thickness with offset studs. They should provide an air gap as well as insulation on the inside of one of the walls. The interior surface of firing range walls should be treated to minimize absorption of airborne particulates, to make cleaning easier, and to resist lead and nitrate penetration. Doors should be made of metal with a foam core to reduce vibration caused by impulsive noise. The entrance to the firing range should be a 4–6 foot passageway with self-closing doors at both ends. The passageway provides an additional gap to reduce noise emissions. Observation room windows should be designed to withstand bullet impacts and to maximize sound reduction. The glass should be laminated and certified as bullet-impact resistant. If double panes of glass are used, then the glass that is in the firing range should be bullet-impact resistant and of a different thickness than the interior pane to increase noise reduction.

Recently, state-of-the-art systems and training equipment designed to reduce lead and noise exposures have been introduced and are gaining wide acceptance among firing range operators and law enforcement agencies. Specifically, new backstop systems are available that eliminate bullet fragmentation and airborne lead by capturing whole, intact bullets into their rubber media. These backstops also reduce noise exposures compared to steel backstops.

Work practice and administrative controls

When engineering controls are not feasible or are inadequate, supplemental work practice and administrative controls may be needed to limit noise and lead exposures. Work practice controls are procedures or actions firing range users can take themselves to ensure their own safety and health. Administrative controls, on the other hand, are those generally implemented by management or firing range operators to safeguard the shooters. The following work practice and administrative recommendations are offered:

Preventing the potential for lead exposure by ingestion and by avoidance of skin contamination and appropriate decontamination

- Eating, drinking, and smoking should be prohibited in the firing range.
- All personnel should wash their hands, forearms, and faces before eating, drinking,

smoking, or having any hand contact with the face or with other people. Hands should be washed with soap and water or cleaned with lead decontamination wipes after shooting, handling spent cartridge cases, or cleaning weapons. Wipes for cleaning skin without water are commercially available and should be used if access to soap and water is limited.

- Skin contact with spent cartridges should be avoided whenever possible. Disposable gloves should be worn when removing larger objects that cannot be removed with a HEPA vacuum cleaner.
- Floor and horizontal surfaces inside the firing range should be cleaned routinely with a detergent, or in some specific and tough cases, a cleanser designed for lead decontamination. EPA studies show that general all-purpose cleaners are adequate for both general cleaning and post-intervention cleaning [EPA 1997, Lewis et al. 2006].

Reducing lead contamination inside the firing range

- The ventilation system should be operating at all times while the firing range is in use and during clean-up.
- The firing range operator should require that all shooters immediately discontinue shooting and place their weapons in safe mode whenever the firing range operation is inactivated by a monitor. All non-essential persons should leave the firing range until the problem is fixed.
- Carpeting should not be used anywhere inside a firing range or in rooms adjacent to the range. Accumulation of lead dust in carpets is a health hazard, and accumulation of unspent primer in carpets is a fire hazard.
- The firing range should be equipped with automatic target retrieval systems to allow shooters to examine their performance without crossing the firing line.
- After use, the floor of the firing range should be thoroughly cleaned with an explosion-proof HEPA vacuum cleaner designed to collect lead dust. Dry sweeping should never be used in the firing range.

Preventing "take-home" lead exposure

- Shooters using a kneeling or prone position over lead contaminated surfaces should place a sheet of paper or other disposable material on the ground beneath them to minimize accumulation of leaded dust on their outer garments. Knee pads or mats may be used to reduce lead contamination but they should be cleaned after each use.
- Shooters and workers should shower, whenever possible, and change clothes at firing range facilities after shooting or performing maintenance or cleaning activities at the range.
- Provide workers with two lockers to allow them to separate street clothes from lead-contaminated work clothes.
- Workers' non-disposable outer protective clothing should be laundered by the employer or a contractor. It should not be laundered by the employee at home. Non-employees who take contaminated clothing home should bag the clothes before leaving the range. Contaminated clothing should be washed separately from the family's clothing.
- Leave shoes worn on the firing range at the range or bag them before leaving the range to prevent lead from being tracked into cars and onto home floors

and carpets. As an alternative, use step-off cleaning pads at the exit of the firing range to help reduce the amount of lead contamination on shoes. Disposable shoe coverings can also be used while firing and cleaning, then discarded upon leaving the range.

Administrative control of noise and lead exposure can be accomplished by limiting the length of time shooters and employees use the firing range, by assignment and work rotation, and by providing quiet and clean lunch and break areas to give periodic relief from noise. The firing range should also be cleaned at least weekly.

Personal protective equipment

Provide personal protective equipment to workers and indoor range users to protect against the potential effects of exposure to lead and noise.

- All workers and shooters should be required to use dual hearing protection devices (earmuffs and earplugs) when the range is in use. For shooters requiring improved communication, NIOSH recommends using electronic level-limiting or sound restoration earmuffs with passive earplugs. In addition to the electronic earmuffs, commercially available communication headsets exist that would permit the range master to transmit instructions via short range radio to the shooter's headset. Shooters should also be encouraged to wear eye protection in the form of safety glasses or goggles that are compatible with hearing and other head protection devices. NIOSH research has shown that wearing earmuffs on top of safety glasses created a leakage in the seal of the earmuff cushions with the ear and reduced the effectiveness and peak noise level reduction of the earmuffs. NIOSH recommends that shooters wear the safety glasses over the top of the earmuff cushions, or use glasses with a strap or low profile stem. Ideally, the safety glasses should be an integral part of the earmuff or other head protection devices. A training program in the appropriate use and fitting of hearing and eye protection should be implemented by firing range training staff.
- Personnel performing lead clean-up at the trap should wear appropriate NIOSH-certified respiratory protection and full protective outer clothing (which may be disposable). If respirators are part of the lead management plan, firing range operators must develop and implement a respiratory protection program that meets the requirements of the OSHA respiratory protection standard [29 CFR 1910.134] and document it in writing.
- Personnel cleaning weapons should be encouraged to use chemical-resistant gloves and tight-fitting goggles for skin and eye protection against potential chemical hazards. Range operators should provide specific guidance about proper and appropriate use of skin and eye protection.

Employer and worker education

Firing range operators and employers should be fully aware of the potential for hazardous lead and noise exposures in their facilities, and they must communicate this information to workers to ensure safe and healthful working conditions.

- Inform workers about the potential for exposure to lead, noise, and other toxicants and tell them the nature of the hazard.

- Provide general information and specific hazard warnings through workplace postings, training, and stating the precautions and hygiene practices required of firing range users.
- Train workers regarding the means available at the firing range to eliminate or limit exposure and the actions that limit potential exposures for themselves and fellow workers.
- Inform workers about symptoms that may indicate a health problem. Although not all exposed workers may show overt symptoms, common symptoms of lead poisoning in adults include nausea, diarrhea, vomiting, poor appetite, weight loss, anemia, excess lethargy or hyperactivity, headaches, abdominal pain, and kidney problems. Exposure to high noise levels can cause hearing problems, stress, poor concentration, insomnia, nervousness, anxiety, and depression. It can also cause accelerated heartbeat, high blood pressure, gastro-intestinal problems and chronic fatigue. Employers should advise employees to report these symptoms to their supervisors and physicians.
- Inform pregnant workers and shooters, or those considering pregnancy, about the possible adverse health effects to the fetus from exposure to lead and noise. A fetus can be poisoned in utero. Studies show that fetal blood contains approximately 80% of the blood lead concentration of the mother. Pregnant workers and shooters, or those considering pregnancy, also need to know about the increased chance of miscarriage at blood lead levels > 5 μg/dL. Evidence also suggests that exposure to peak sound pressure levels above 155 dBC can cause hearing loss in the fetus beyond the fifth month of pregnancy. The evidence of whether the particular noise exposure associated with firing ranges is harmful to the developing fetus and warrants removal of the pregnant woman from exposure is ambiguous. This issue is further complicated because female workers may be exposed to lead and noise even before they know they are pregnant. Firing ranges might wish to establish guidelines for pregnant workers exposed to lead and noise.

Worker exposure and medical health monitoring

OSHA's lead standard requires each employer who operates a firing range to determine if any workers may be exposed to lead at or above the action level (30 $\mu g/m^3$ as an 8-hour TWA). Worker exposure is defined as that exposure which would occur if the workers were not using a respirator.

The results of initial and periodic monitoring determine whether subsequent monitoring is necessary. Monitoring also determines whether other protective provisions of the standard need to be implemented.

If the initial determination or subsequent determinations reveal workers' exposure to be at or above the action level but at or below the PEL, the employer is required to perform monitoring at least every 6 months. If the initial determination reveals that workers' exposure is above the PEL, the employer must perform monitoring at least quarterly. If any worker is determined by the initial monitoring to be exposed to lead below the action level, then no further monitoring is required for that worker, except where firing range operations or controls change that could result in additional exposure.

Exposure monitoring

- Monitoring procedures should be specifically defined to ensure consistency. Instrumentation, calibration, measurement parameters, and methods for linking results to worker records should be clearly outlined.

- Exposure assessment should be conducted under the direction of a certified industrial hygienist or other safety and health professional with appropriate training and expertise.

- Workers should be permitted and encouraged to observe and participate in monitoring activities as long as they do not interfere with monitoring procedures. Their participation will help ensure valid results.

- Monitoring should be repeated periodically to ensure continued effectiveness of worker protection measures and to help identify changes in noise controls, work practices, equipment, and maintenance procedures.

- Perform wipe sampling on surfaces in the firing range on a regular basis. Wipe sampling can provide information about how well these surfaces are being cleaned, whether lead is being transported from the firing range to other parts of the facility, and about the potential for lead exposure. See information about the NIOSH wipe sampling methods in *Current Regulations, Recommendations, and Other Guidelines* section of this Alert.

- Employers should notify workers of any hazardous exposure levels determined for their particular jobs and provide information about the health risks associated with such exposures.

Worker health monitoring

Blood lead levels are currently the best indicator of personal lead exposure. Workers potentially exposed to lead should therefore be monitored for the presence of lead in blood. This assessment is necessary to ensure that engineering controls, personal hygiene practices, and PPE are preventing lead exposure. It is recommended that the employer's medical monitoring program be supervised by a physician trained and experienced in occupational medicine.

- The OSHA general industry lead standard contains provisions for the medical monitoring of workers exposed to lead (29 CFR 1910.1025(j)). NIOSH supports using these provisions for firing range workers, especially those who routinely use or work at these ranges, but acknowledges that current understanding of health risks associated with lead exposure may require updated/additional provisions for medical surveillance. Recommendations from the March 2007 edition of Environmental Health Perspectives' Mini-Monograph on adult lead exposure and from the Association of Occupational and Environmental Clinics (AOEC) include the following elements:

  — Informing workers and shooters that levels of lead once thought safe are now known to be harmful. Advise that blood lead levels be kept below 10 μg/dL of blood.

  — Informing pregnant workers and shooters, or those considering pregnancy, about the possible adverse health effects to the fetus as well as the increased chance of miscarriage at blood lead levels > 5 μg/dL.

- Workers should be included in a medical surveillance program whenever they are handling or distributing materials with lead content that could potentially cause exposure through inhalation or ingestion.

- New employees and those newly assigned to work in areas with potential lead exposures should have a preplacement lead medical examination and a BLL test, followed by periodic BLL monitoring, blood pressure testing, and health status review.

- Monthly BLL testing is recommended for the first three months of employment in order to assess the adequacy of exposure control measures.

- Testing frequency can be reduced to every six months as long as BLLs remain below 10 μg/dL or quarterly for individuals with blood lead concentrations between 10 and 19 μg/dL.

- Any increase in BLLs of 5 μg/dL or greater should trigger a re-examination of control measures.

- Workers with BLLs of 30 μg/dL or more, or ones with a sustained BLL above 20 μg/dL should be removed from lead exposure.

- All lead-exposed workers should receive, annually, educational materials and prevention information about the health effects of exposure to lead from a clinician and the employer, and they should be provided necessary protections including protective clothing, clean eating areas, and hygiene measures such as wash facilities and/or showers to prevent both ingestion and take-home exposures.

- The OSHA noise exposure standard (29 CFR 1910.95(d)(e)(g)(h)) requires the employer to establish a monitoring program and provide audiometric testing to all employees whose exposures equal or exceed an 8-hour TWA of 85 dBA under the action level monitoring criteria. All workers with regular exposure to weapons firing should undergo annual audiometric monitoring at test frequencies of 500, 1000, 2000, 3000, 4000, and 6000 Hz. Annual audiograms should be compared to a baseline audiogram to determine if hearing loss is occurring. If a standard threshold shift (STS), defined as a change in the pure-tone average of more than 10 dB at 2000, 3000, and 4000 Hz, occurs in either ear, the employer must follow certain procedures outlined in the standard, including notifying the affected employee in writing. Occupational exposure to lead can have an additive or potentiating effect on the auditory system and increase the potential for hearing loss. Pure-tone audiometric testing may conceal certain hearing difficulties caused by exposure to lead or other chemicals. Professionals who review the audiometric results should be alerted to this issue and should consider a referral for further testing and medical evaluation [Morata, 2007].

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We greatly appreciate your assistance in protecting the health of U.S. workers.

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